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ARMING FOR PEACE

A BUSINESS man of large experience when about to sign an agreement defining the future relations between his firm and another party, remarked: "We must remember that an agreement is simply a memorandum of what both parties intended at the time of signature. It is impossible to draw up a form of agreement, out of which a way cannot be found, if either side lacks honesty or goodwill." The present war is largely due to the mistake of relying upon "pacts" without being assured of the necessary background of HONESTY and GOODWILL.

In considering the subject of "Arming for Peace" on which the Editor of *Current Science* has requested an article, it would seem necessary in the first place to examine the ultimate foundations on which these two essential factors of peace must be based.

We must realize then that honesty is something more than "the best policy". Hitler, indeed, has worked out a technique of lying, amongst other items of which is the subtle propagation of half-truths, designed to confuse issues, and to deceive even well-intentioned people. It is unfortunately often the case that lack of wisdom with good intent, may be as mischievous in its results as intellectual subtlety with evil intent. A mouse by causing a short circuit in the power house has put a whole city in darkness.

True honesty must get down to the bases of thought and resulting action. "Clear your *mind* of cant" said the rough spoken but essentially honest Doctor Johnson. This means the unwearied endeavour to reach the truth about any situation. To the old question—"What is Truth?" the reply may

be made that Truth is that which is capable of being "known", as apart from what is merely surmised or believed. The advance in physical science has consisted in the substitution for crude theories and superstitions, of demonstrable knowledge more closely in accord with truth. So in the field of religion, in which may be included all those interests which concern the spiritual rather than the material welfare of man, the same process may be noted. It is not so very long since the majority of religionists, Christian and other, believed in the "plain flat-footed hell" of the Fundamentalist and of Calvinistic theology, the nightmare arguments about which rocked the sanity of the gentle-minded Cowper. These beliefs may still be found "under cover". Even though we may no longer believe in the eternal burning of unbaptized infants, we have all read of, if we have not seen, the mangled bodies of the innocents, massacred by the modern Herod.

It is clear, then, that while the old meaning of being "saved" was to be freed from fear or punishment in a hell of fire and brimstone after death, our present need is to be rescued from the constant menace of the hell of war.

There is a gruesome picture in a small museum in Brussels devoted to the works of the half crazy artist Wiertz entitled: "Napoleon in Hell" where the dictator of that day is seen in an atmosphere of flame, filled with the cursing faces of the women who had lost husbands and sons in his wars. We shall not dispose of Hitler or Hitlerism by hating after this fashion.

To "know" the truth about any situation or individual it is necessary to be absolutely honest with ourselves. The attainment of such honesty is not easy. It means the casting out of the mind of all suggestions which do not measure up to our highest sense of good. We must learn, *i.e.*, continually to reject these "suggestions" and to recognize the clarity of perception which accompanies the "knowing" of truth. In proportion as we are successful in this task we shall be less liable to be led astray by the half-truths of Hitler or any other propagandist.

This, which may be called the "way" of Truth has been known to enlightened thinkers through the ages. Apart from prophets and philosophers hints are to be found in the writings even of such pioneers in physical science as Paracelsus and Van Helmont, blurred though they may be with the mist of error.

A man may slowly arrive at the Truth through stress or misfortune, or he may awaken to it suddenly, just as some accidental incident may reveal to him that he is in love.

That one member of a scientific research staff who had spent happy student days and made many friends in Copenhagen became almost physically ill at the thought of the muddy vileness of the Nazi overflowing of Denmark, is evidence of real emotional reaction and honest indignation. Mr. Gandhi's tears, when first made aware of the possible destruction of ancient monuments in London, also indicate a flash of "clear perception". Sad that it should so soon be clouded over with religio-political subtleties, suggestive of a spiritual "smart Alec" rather than an inspired leader. The self-imposed and well advertised martyrdoms of the satyagrahis fail to impress those whose friends and relations are quietly going about their

avocations in England in daily peril of their lives.

What to the plain man seems a treacherous taking of political advantage is not likely to inspire confidence in the justice of the propagandists in their other relations to public life.

In a conference held by a religious body many years ago in Manchester, during a discussion on the value of creeds, it was finely said by one speaker—"In the last analysis it is character which counts."

It seems to be forgotten that "Votes for Women" were conceded not because of the hysteria of the suffragettes, but because when war came all these extravagances were forgotten and women were found in the munition factories, in the transport services and in other spheres of activity efficiently carrying on the work of their husbands, sons and brothers in the trenches, and so *proving* their fitness for the responsibilities of citizenship.

The driving force behind the women's suffrage movement was, moreover, not mainly political, but was born of a passionate resolve to end if possible the exploitation of women by reason of the possessive and acquisitive inclinations of society. In the peace for which we are arming it may be hoped that exploitation in any form of the weak by the strong will be universally condemned.

Although a fierce civil war was fought for the intended "abolition of slavery", it is doubtful whether even yet it is fully realized that cash is not the equivalent of kindness, and that what is sometimes termed "wagery" may be even more soul destroying than "slavery".

A difficulty which may be encountered in our endeavour to "know" the Truth is that many of us are mental "flatlanders" unable to perceive anything outside our 2-dimensional consciousness. With perseverance and continued honesty of purpose and desire, we may attain to a 3- or even to an n-dimensional consciousness. IDEAS, after all, are not dimensional at all. Thus it happens that those of humble mind who are willing to listen and learn, may arrive soonest at clarity of perception. With this clarity comes real POWER. Hitler, with all his concentration camps and Gestapo officials, has not the power of a little dog to inspire affection, or to heal one heart-break.

Among the four most "powerful" men the world has known, Bertrand Russell includes Galileo, who was free from fear through his perception of the reign of law in physical phenomena. Others, seeing further even than Galileo, have realized the reign of law in the spiritual or undimensional world of ideas.

A main cause of war is *fear*. Why should we fear for our foothold in life if, like Galileo, we know that we are supported on the girders of the universe? Why should we fear poverty and lack when the resources of the world are available to all, if intelligent ideas are rightly applied?

Why fear sickness when the poisons of hate and envy, greed and jealousy, malice and resentment have been eliminated from the system by the cleansing of the mind?

And what of that "undiscovered country" which "troubled the will" of Hamlet? What does the chrysalis know of the butterfly or the acorn of the oak, or either of these of the never ending life which passes from form to form?

Apart from these fears born of forgivable limitations of consciousness, another alleged cause of war and unrest is *boredom* arising from ignorance, apathy and inertia. Even war may be preferred to dullness and lack of interesting occupation. Hence the success of the appeal of the Nazi and Fascist to the unemployed or mentally unoccupied youth of Germany and Italy. In arming for peace as for war, it is wise to be willing to learn from the enemy, since many of his ideas may be, in themselves, good, though inverted by him in order to serve the purposes of evil.

The writer in his younger days was privileged to be on terms of friendship with a learned lexicographer and master printer, from whom he often caught words of wisdom. On one occasion the dear man remarked—"You know the apparent dullness of a subject is often simply a measure of our ignorance of it" and proceeded to prove his point by discoursing charmingly on Chinese ideographs!

When we become conscious of the world of *Ideas*, our vision will be immensely enlarged and we shall come into our inheritance of joy, already glimpsed by the artist, the poet and the scientific worker, by all those indeed whose activities are creative and not simply self-regarding. When all men see these things there will be peace, for the roots of discord will be cut away.

To know these things does not require learning or wealth. The Madras fisherman in his catamaran brings expert ability to bear on his job, equally as effectively as the zoologist in his laboratory. The artistic arrangement of flowers in a vase may be the gift of an Indian "room-boy", as well as the taught accomplishment of the Japanese "geisha". Nevertheless it would be well if it were more generally realized that "simplicity" of life does not mean squalor or lack of "fineness".

HONESTY and GOODWILL—two simple words, best understood by simple folk. It may well be that only such will be present at the final Peace Table, since they alone represent the common people who always bear the chief burden of the calamity of war. They are the people who will stand for tolerance and fair-play. Even in a slum street fight they are those who shout "Go it little 'un!" While these simple folk may not all belong to the poor or "underprivileged" classes, they will many of them know what it is to be out of employment and to wonder where the next week's wages, or the next month's or year's salary, is to come from. Many will have seen their homes crashing in the air-raid, will have shared these dangers with their wealthier neighbours and will have been welded into a common brotherhood with them. A social revolution, truly, but with no hint of tumbrils.

At the peace table or in the peoples parliament to follow, we may hope to see the sons and brothers of the "simple folk", who will bring to their duties as representatives of the people courage, quickness of apprehension and power of prompt decision, learnt in the skies, on the tumbling seas, or during the patient vigil of the watching post.

These "simple folk" will take no joy in revenge, but will gladly welcome decent people of all nationalities and races into a commonwealth of mutual service. The moral "sickness" of "others" they will hope to see healed in course of time in the atmosphere of compassion arising from "understanding".

Should there remain individuals too dangerous and criminal to be allowed at liberty, they may be dealt with in a spirit of justice and equity, with a view equally to their own good and to that of society.

The "simple folk" will welcome the special qualities and aptitudes of all nations and peoples in so far as these contribute to the general welfare of humanity.

The "simple folk" will have come to realize clearly through the hard facts of their economic life that *money* is not *wealth*, and they will seek to free the world from the age-old illusory worship of gold with all its attendant miseries.

They will strive to bring about the substitution of true business founded on fair exchange of goods and services for the scramble of the market place, and competition in excellence for the crude competition of the profit motive, which is only a form of continuous war.

At the peace table there must be wide tolerance for differences in culture and religion. The "simple folk" will not despise any who may not have climbed the hill of understanding so far as to be able to see the view which they see, nor will they envy those who are higher on the mountain side than they. All, they are well aware, will reach the summit at last.

The people of honesty and goodwill are not likely to find difficulty in replying to the common arguments of the defeatist. How, it may be questioned, can men and nations of different language, religion and culture live and work together? The answer may be that there are things on which all men of honesty and goodwill are agreed which are amply sufficient to give plenty of work for any form of Federal Government. For the rest let those things on which there cannot be agreement be left to the care of each body concerned. Let Hindus attend to the special interests of Hinduism, Muslims to the affairs of Islam. So with Catholic and Protestant, Teuton and Latin, Celt and Saxon. Successful examples of such collaboration are not hard to find, given honesty and goodwill, notably Switzerland, Canada, or as a nearer instance even the State of Mysore.

It is evident that a successful peace must depend on the number of "simple folk" available of the type indicated. It is for each one of us to seek to qualify for a seat at the table by daily and continued effort to increase our understanding of the inner meaning of HONESTY and GOODWILL. It will involve striving, not spasmodically, but minute by minute, hour by hour, day by day to attain a clearer vision of the essential truth of things, by the process of mental cleansing already described. This may mean some sacrifice of ease and occasional weariness of spirit. "Thinking is the hardest work there is" says Henry Ford. One of the members of the Indian Defence Force in the last War has not forgotten the words of the officer instructing the newly joined recruits: "You may think", he said, "that all these drills and tiresomely detailed instructions are rather useless; but remember that when it comes to the 'real thing' if you do not instinctively know your drill, you will be 'all over the place', whereas with training, it may be hoped that you will retain some sort of order".

In such manner, therefore, let us arm for Peace.

GILBERT J. FOWLER.

GENESIS OF EARTH

In dim, impenetrable, mystic dawn of time
The Grand Designer set the worlds in space
To revolve restless and fly in starry speeds
Unclashing;—each in its assigned airy path—
All held in bonds unseen and knit in space
To fit His lofty plan of Firmament
Of endless, star-strewn, growing universe.

In times unknown—some tens of trillion years ago—
When the wearied Watcher drooped His wary eye,
Two vagrant stars from depths of space onrushed
And crashed to myriad bits;—their smithers afire
Did blaze in space to mass incandescent.
Hurtled loops of these shattered stars—tied down,
Like fleeting souls to mortal trails awhile—
Flew round and round; their cruel fate cursing
Which sped their promising life to tragic end.
Some wailing waifs outswerved their orbit course
And clashed again; but venomless, firm and true
That they, like clasping drops of silver live
Cohered anew and grew as glowing worlds.
From the roving wrecks thus fused afresh arose
Our Earth and Mars and rest planets diverse,
Which speed around the re-built nuclear sun,
As specks of sands in endless ocean space.

Or perchance, the cooling star-crashed nebular globe
Gave birth at first to our luminant central sun
Who, turning topwise in terrific speed, thrust out
His glowing gaseous sward to swollen knots
Which, cut and hurled aloft, went swirling out
To whirl round him in pointed paths; such ejected knots
Of gaseous globes cooled, in stages diverse,
To deck the sky as planets of varied size
And that which chilled to air-filled stony crust
Evolved as Earth, to hold our souls in trust.

R. R. B.

A CENTURY OF LIEBIG'S THEORY OF MINERAL NUTRITION OF PLANTS AND OF SOIL FERTILITY

BY

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IT is now a century since Liebig, the German Chemist, announced in the year 1840, his theory of the mineral nutrition of plants and soil fertility. The announcement is not only an important landmark in the progress of knowledge of the chemistry of plants and the science of plant nutrition and crop production, but is the foundation of Agricultural Chemistry as we know it to-day.

The history of science abounds with instances in which thought and research changed from time to time following discoveries of fundamental importance. Such discoveries, eventually directed experiment and thought into new fields, leading to new knowledge and expansion in scientific outlook, without at the same time invalidating previous knowledge and experience. Liebig's theory is an example in point. It will be interesting and instructive to briefly recapitulate the major developments leading to Liebig's theory and to review the experience and the trend of research and thought on soil fertility and plant nutrition during the century that has elapsed.

Till Liebig expounded his views in the year 1840, the "humus theory" of plant nutrition held the field and it was believed that plants should be nourished by a substance of a similar nature. Chemistry and Agricultural Chemistry as they are known to-day had their beginnings in the mists of alchemy. In those days the knowledge of the constitution of matter was only in terms of the four elements or primordial materials of the Aristotelian philosophy, *viz.*, fire, air, earth and water. Towards the end of the sixteenth and the beginning of the seventeenth centuries Paracelsus taught that life was a chemical process and that the bodies of animals and plants were chemical laboratories. The belief was held that compounds manufactured by life processes in the bodies of animals and plants could not be made in the laboratory.

The discovery of several chemical elements in rapid succession between the years 1750 and 1800 and the development of quantitative methods of experimentation by Lavoisier and de Saussure marked the beginnings of Agricultural Chemistry and the study of the chemical composition of plants received a powerful impetus. The synthesis of urea in the laboratory by Wöhler in 1828 was another step in advance. It finally disposed off the distinction between substances made by life-process in the bodies of animals and plants and those made in the laboratory. These developments opened up fresh fields of enquiry and led Liebig to turn his attention to plant chemistry. He made chemical analyses of the ashes of plants and manures, carried out experiments on a piece of uncultivated land at Gissen and discovered that by applying to the soil nothing but mineral salts he could turn the land into as fertile a spot as could be found in all Germany. He discovered that plants could absorb minerals and assimilate them and could manufacture their organic materials from air and water. He attributed the effectiveness of farm-yard manure to the mineral salts of phosphorus, potassium, sodium, calcium, magnesium and others contained in the manure and also found in plant ashes, dismissed the humus theory and announced his mineral theory of plant nutrition and soil fertility.

Although this announcement raised a bitter controversy in the beginning, its value was eventually recognised. Liebig, by analysis and synthesis of the then existing data, clarified the ideas on plant nutrition, placed them on a scientific footing and simplified manuring of crops. A chemical analysis of the soil would indicate what was lacking or inadequate in it and the restoration of the lacking or inadequate element to the soil would restore its fertility. It was all so simple and easy, and therefore these ideas of chemical treatment of the soil rapidly gained favour. The use of artificial or chemical fertilisers became popular and a huge artificial fertiliser industry had arisen.

The earlier experiences in the practical application of the theory to the humus rich

soils of the temperate climates of Europe gave such unqualified support to the theory that it was believed that artificial or chemical fertilisers could for ever effectively substitute farm-yard manure and other organic manures. The belief developed that farming might be only chemistry and a matter of supply of mineral salts to the soil. Plant nutrition came to be regarded as entirely a matter of direct mineral absorption and plant nutritional and agrobiological concepts have been developed and interpreted in terms of fertiliser elements.

Subsequent developments provided evidence that soil fertility was not quite such a simple matter as that. Towards the end of the nineteenth century discoveries, led by Pasteur, of bacteria and his studies on fermentation processes assumed a definite stage and shape, and threw light on the biological processes in the soil, and brought the realisation that in soil fertility there was something more than continuous supply of mineral fertilisers. About the year 1850 Pasteur pointed out that important changes especially oxidations are brought about by Micro-organisms. In 1877 Schloesing and Muntz and a little later Schloesing established the oxidation of soil organic matter to nitrates by bacteria. In 1888 Hellriegel and Wilfarth investigating the problem of nitrate supply and plant-growth observed that while graminaceous plants failed to grow without nitrate supply leguminous plants could do so. This was ultimately traced to symbiotic nitrogen fixation. Towards the close of the century Knox, Winogradsky and others showed that atmospheric nitrogen was fixed in the soil by azotobacter.

The birth of the twentieth century saw the extension of the zone of soil and plant research to countries outside Europe and America and included the hot, humid, and dry tropics. The increase in the number of research workers working under different conditions of soil, climate and crops soon widened the scope of enquiry. Gradually knowledge accumulated. The importance of organic matter and micro-organisms in the soil became apparent. Soil processes and the nitrogen and carbon cycles became clearer. Farmers and experimenters were puzzled by the fact that manures like form-yard manure, relatively poor in mineral plant foods and in their availability, produced equally good and even better results than mineral fertilisers. The long period experiments at Rothamsted in England and at Pusa and Coimbatore in India showed that although in the earlier years mineral or chemical fertilisers could produce better results than farm-yard manure, their continued application tended to decrease crop yields compared to farm-yard manure and green manures. Mineral or chemical fertilisers began to find their place as immensely important but not all-important. The sustained and better action of the organic manures was, however, attributed to the better moisture-holding powers of the soil.

Then came studies on human and animal diets and the discovery of vitamins. Once again vistas were opened up. Workers in animal and plant chemistry began to find common ground. Such important characteristics as sexual differences and sexual reproduction and such vital functions as respiration in plants are recognised to be similar to those in animals in their fundamental principles. But, no such similarities were yet thought of in regard to the fundamental nutritional requirements of plants and animals. The role of organic matter on crop-growth was considered to be only indirect and the existence of accessory factors in plant nutrition similar to vitamins in animal nutrition were either not considered or disregarded.

Bottomley[1] and later Mockeridge[2] announced for the first time that extracts of fermented organic manures gave to plants certain growth-promoting substances which they called "*auximones*" and which they considered essential to plants. The hold of Liebig's mineral theory was still strong and Maze[3] just then showed by water-cultures the importance of trace elements for plant-growth. The views of Bottomley and Mockeridge were vigorously opposed and their results were explained in the light of Maze's results. Bottomley died and Mockeridge in a later communication[4] even abandoned her former views on the direct effect of organic matter on plant-growth.

Nevertheless, the experiences in the field and in the laboratory compelled investigators to revert to this question on the effect of organic matter and manures on soil fertility and the work of the last two decades in India and outside has recorded notable advances and opened up new lines of thought and research.

The work in India of Viswa Nath,[5] McCarrison and Viswa Nath,[6] and Viswa Nath and Suryanarayana[7] has provided a complete picture and has thrown new light on the role of organic matter and micro-organisms in plant nutrition and on the interrelationship between, and the inter-dependence of the three components of the system soil-plant-animal. These workers have shown that organic manures play a part hitherto unsuspected and that they provide certain substances analogous to vitamins which are absorbed and assimilated by plants leading to improvements into the quality of the end products of plant metabolism either as food or seed material. They have stated on the basis of their experimental evidence that:

1. Plants also have accessory food factors, akin to vitamins, for proper development and reproduction.
2. Organic manures have as one of their functions the supply of these accessory food factors.
3. There exists a cycle or chain of accessory factors beginning with soil micro-organisms and ending with returning to the soil through plant and animal bodies.
4. Nutritional factors for animals are associated with nutritional factors for plants.

These views which were published in 1926 not only did not receive acceptance, but even roused opposition due to partly to their newness and the knowledge being incomplete and partly to the difficulties experienced in getting clear of the narrow view-points resulting from a too limited experience. In the few years that have elapsed more data have been obtained in different parts of the world in support of the views mentioned above.

At a discussion held by the Royal Society of London in the summer of 1937[8] the available information scattered in several publications was reviewed and it was recognised that the case established in the nutrition of animals was equally established in the nutrition of the most diverse varieties of cells and that all cells from the lowliest bacterium to the cells of the highest animals carry out the series of reactions leading to the production of energy and growth by the help of substances mostly of the nature of vitamins in animal nutrition.

The isolation of *auxins*, substances concerned in the growth of plants, by Kögl in a crystalline form from urine, malt, yeast, liquid manure and farm-yard manure, and Kögl's observations on the existence of a cycle of growth factors in nature[9] provided further support to Indian work. The work of Thimman,[10] of Link[11] on the role of micro-organisms as factors in the regulation of plant processes; and the work of Link[12] and of others have provided evidence in support of the statement on the effects of organic manures and substances produced by microbial fermentation.

McCarrison and Viswa Nath[13] have drawn attention to another aspect of the subject. They have shown that manurial and fertiliser applications are capable of reacting on plants not only by increasing yields, but also by influencing the quality of the seed and by bringing about changes in the composition and nutritive value of the produce, and that in this respect the produce raised with mineral fertilisers on soils poor in organic matter is inferior to that raised with farm-yard manure. These observations find support in the results of work by Rowland and Wilkinson,[14] Thomas and Thompson,[15] Booth,[16] and of Howard[17] in England; Ysabel Daldy[18] in New Zealand, Tallarico[19] in Italy; Hunt,[20] Breazeale,[21] Thompson[22] in America; Kruger,[23] Kottmier,[24] Wachholder and Nehring,[25] Smallfuss,[26] and of Rudolph Berk[27] in Germany. On the other hand the results of Harris[28] in England, Schunert and his associates in Germany[29] do not support the view that fertilisers and manures influence the nutritive value of crops. In 1936–37 experiments were made in Germany under the joint auspices of the Association for Scientific Research, the National Board of Health and the Society for Nutrition Research. The nutritive value of vegetables grown with animal manure plus fertilisers were tested. On adults the results showed no definite effect. On children the results showed that vegetables grown with animal manure and artificial manure together were superior to those grown with animal manure only. In similar experiments in New Zealand by Chapman[30] vegetables grown on humus-treated soil when fed to school children were found superior to vegetables raised with mineral fertilisers. There are thus two schools holding opposing views and the existence of these differences is the greatest stimulus for further investigation and elucidation.

Although our ideas have undergone changes and notable advances have been made since Liebig's days, the original theory is still valid. But the humus theory which prevailed a century ago is again coming into its own but in a qualified manner. The developments of the past century direct pointed attention to one important aspect, namely, the differentiation between soil fertility and soil fruitfulness. Organic manures and organic fertilisers build up and maintain soil fertility for artificial fertilisers to be fruitful. It is in the recognition of this truth lies the reconciliation of the opposing views. There is also the growing recognition that we are at the beginning of new knowledge and that workers in plant and animal nutrition may increasingly find common interests in the studies on cell metabolism. We are indebted for our present knowledge to the pioneers of the past and look forward to future developments which may give us more knowledge and control over soil fertility.

[1] *Proc. Roy. Soc.*, (B), 1914, **88**, 237.
[2] *Ibid.*, 1917, **89**, 508.
[3] *Ann. Inst. Past.*, 1914, **28**, 21.
[4] *Ann. Bot.*, 1924, **38**, 723.
[5] *Jour. Madras Agric. Student's Union*, 1926, **14**, 19.
[6] *Ind. Jour. Med. Res.*, 1926, **14**, 351.
[7] *Mem. Dept. Agric. Ind. Chem. Series*, 1927, **9**, 85.
[8] *Proc. Roy. Soc.* (B), 1937, **124**, 1; *Nature*, 1937, 161.
[9] *Chem. Ind.*, 1937, **57**, 49.
[10] *Jour. Gen. Physiol.* 1934, **18**, 23.
[11] *Bot. Gaz.*, 1937, **98**, 816.
[12] *Nature*, 1937, **140**, 507.
[13] *Loc. cit.*
[14] *Biochem. J.*, 1930, **24**, 199.
[15] *J. S. C. I.*, 1938, **57**, 210.
[16] *Ibid.*, 1940, **59**, 181.
[17] *Chem. and Ind.*, 1938.
[18] *Nature*, 1940, **145**, 905.
[19] *Mem. Acad. Ital. Boil.*, 1932, **3(1)**, 5.
[20] *Ohio Exp. Stn. Ann. Rep.*, 1928.
[21] *Univ. Arizona Tech. Bull.*, 1927, **16**.
[22] *Proc. Amer. Soc. Hort. Sci.*, 1937, **34**, 599.
[23] *Landw. Jaharb.*, 1927, **66**, 781.
[24] *Kuhn. Arch.*, 1927, **15**.
[25] *Bodenk. Pflanz.*, 1938, **9/10**, 708.
[26] *Phytopath Z.*, 1937, **5**, 207.
[27] *Boden. U. Pflanz.*, 1939, **12**, 129.
[28] *Biochem. Jour.*, 1934.
[29] *Biochem. Z.*, 1934–39.
[30] *Nature*, 1940, **145**, 905.

OBITUARY

Mr. NOSHIR S. DOCTOR, M.Sc., A.I.I.Sc.

A PROMISING scientific career was tragically cut short by the death on May 26th last of Mr. Noshir Shapoorji Doctor, as a result of injuries sustained in a motor-cycle accident at Bangalore. Mr. Doctor was working for the PH.D. at the Indian Institute of Science.

Born on March 4th, 1914, at Broach, near Bombay, Noshir Doctor was educated at the Government High School, Broach, and matriculated in 1931. He joined St. Xavier's College, Bombay, in that year and except for a short break in 1933 at Karachi, was there till 1936, when he graduated with a First Class and Distinction in Chemistry, securing the College Gold Medal. He then joined the Indian Institute of Science, Bangalore, and three years later, secured the M.Sc. degree of the Bombay University and the Associateship of the Indian Institute of Science.

Possessed of sterling qualities of head and heart, Noshir Doctor had won the regard of both his Professors and colleagues. He was a good sportsman and, both at school and college, distinguished himself on the field. He won a number of prizes in sports at the Centenary Celebrations in connection with the anniversary of the late J. N. Tata.

Such a premature death at the age of 26 and at the very threshold of a career that held every promise of being very successful, the news of his tragic death came as a great shock to his many friends at Bombay and Bangalore. To his bereaved parents and relatives we offer our sincere condolences.

J. P. DE SOUZA.

LETTERS TO THE EDITOR

A Note on the Analysis of a Special Complex-Experiment

Sometimes it happens that the number of different treatment-combinations of a manurial complex-experiment is $[(p-1)\,q+1]$ and not pq. Thus, for example, taking the case of a manurial experiment which involves p manures (including no manure) and q times of application, the number of different treatment-combinations is $[(p-1)\,q+1]$. The analysis of such an experiment cannot be carried cut in the usual way. This note indicates briefly the method of analysis of such an experiment.

The sums of squares for blocks, the treatment-combinations and the residual error are calculated in the usual way by fitting constants, as explained in a previous paper.[1] To get more information about the manures, the time of application and the interaction, the sum of squares for the treatment-combinations is split up as follows:—

Variance due to	*Degrees of freedom*
1. No manure *versus* all the other manures taken together	1
2. Between the different manures (excludes no manure)	$(p-2)$
3. Between the times of application	$(q-1)$
4. Interaction	$(p-2)\,(q-1)$

The sum of squares for the different items mentioned above can be calculated as noted below:—

1. Reduction in the s.s. by fitting constants for block effects, no manure and all the different combinations taken together—s.s. for blocks.

2. Reduction in the s.s. by fitting constants for block effects, no manure and the different manures—(s.s. for blocks + item 1).

3. Reduction in the s.s. by fitting constants for block effects, no manure and the different times of application—(s.s. for blocks + item 1).

4. S.s. for $[(p-1)\,q+1]$ treatment-combinations—total of items 1, 2 and 3.

P. V. Krishna Iyer.

Imperial Agricultural Research Institute, New Delhi,

November 29, 1940.

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[1] *Proc. Ind. Acad. Sci.*, **11**, 369.

Sound Velocity in Liquid Mixtures

In an earlier paper,[1] I proposed a relation between the velocity of sound v in liquids and its molecular volume V, *viz.*, $v^{1/3}V = R$ where R is a constant independent of temperature. It is found that the constant R is an additive function of the chemical composition. Isomeric substances of similar constitution have the same value of R. Further the difference in R between successive members of a homologous series has a constant value independent of the type of compound. The mean difference corresponding to the value of R of the CH_2-group has been found from the examination of several series to be 195.

The velocity of sound in mixtures of liquids has been determined by a number of investigators[2] either by the method of diffraction of light by sound waves of high frequency or by the Sonic Interferometer. If the values of R of solute and solvent are additive then the value of R for the mixture is simply given by

$$R_{12} = xR_1 + (1 - x)R_2 \quad (1)$$

where R_1 is the value of R of the solute and R_2 that of the solvent, and R_{12} that of the mixture. x is the molar fraction of the solute. The quantity R_{12} is given by

$$R_{12} = \frac{M_{12} v_{12}^{1/3}}{\rho_{12}} \quad (2)$$

where v_{12} and ρ_{12} are the measured velocity of sound and density of the liquid mixture respectively; M_{12} is the mean molecular weight, thus $M_{12} = xM_1 + (1 - x)M_2$, M_1 and M_2 being the molecular weights of the solute and solvent respectively. The value of R_{12} calculated from R_1, R_2 and x according to equation (1) is compared with the value of R_{12} obtained from M_{12}, v_{12} and ρ_{12} according to equation (2) and it is found that the agreement is excellent. As an example the results for solutions of butyl alcohol in heptane are given in the following table:—

x	ρ_{12}	v_{12}	R_{12} acc. to (2)	R_{12} acc. to (1)
0·2570	0·7004	1139	1393	1394
0·4843	0·7252	1155	1266	1270
0·7457	0·7603	1190	1125	1128
0·8243	0·7735	1205	1084	1085
1·0000	0·8061	1245	989	..

$R_1 = 989$, $R_2 = 1535$.

Equally good agreement has been obtained for solutions of benzene, carbon disulphide, ethyl acetate in carbon tetrachloride. Equation (1) can, therefore, be applied to determine the values of R_1 or R_2 from measurements of the velocity of sound in, and density of, solutions instead of pure liquids. If the mixture law given in equation (1) is extended to the case where the solute is a solid, it is possible to calculate the velocity of sound in solids. Details will be published very soon.

M. Rama Rao.

Department of Physics,
University of Mysore,
Bangalore,
December 11, 1940.

[1] M. Rama Rao, *Curr. Sci.*, 1939, **8**, 510; *Ind. Jour. Phy.*, 1940, **14**, 109.

[2] Bergmann, 'Ultrasonics and their Scientific and Technical Applications'.

Ammonia Synthesis from Active Nitrogen and Hydrogen

The classical work of Haber,[1] Le Rossignol,[2] Nernst[3] and numerous others has established the principal optimum conditions for the above reaction produced thermally. Under different types of electrical discharge, however, the ammonia yields are poor even when the variously mixed gases, are activated in the presence of a number of substances. The results have, however, revealed the operation of some significant factors. Anderson,[4] for example, employing slow moving electrons has found that ammonia formation is negligible at voltages short of the ionisation potential of nitrogen; according to Lewis,[6] a mixture of active nitrogen and atomic hydrogen is reactive; Dixon and Steiner[7] observed ammonia with

active hydrogen and nitrogen in the presence of iron, nickel and copper.

Besides these and similar observations which are mainly of theoretical importance, no systematic and detailed information is available in the now considerable literature on active nitrogen in regard to its utilisability for ammonia synthesis. In the course of studies of its interaction produced under a variety of conditions with a wide range of substances, we have found that (*i*) secondary ionisation is practically the only necessary and sufficient condition for the activation of nitrogen, and that (*ii*) its deactivation results by the continued operation of the exciting field. Result (*i*) is at variance with the view adopted in some of the standard works as to the necessity of a "*condensed discharge*"[5]; it serves, however, chiefly to increase the density of ionisation and therefore, of active nitrogen. We have found that hydrogen even in small proportions acts anticatalytically towards active nitrogen. Besides the influence of this factor, it is to be anticipated from (*ii*), that but small yields would follow any reaction involving active nitrogen with a *stationary* mixture of nitrogen and hydrogen under the discharge. The experimental results were in agreement with this deduction. A careful streaming of the glowing gas at an adequate pressure-gradient was of primary importance. The catalyst, selected from amongst materials found previously to be sensitive towards active nitrogen, was placed in the '*after glow*' of the streaming gas. In a large number of cases nitrides were found; these gave ammonia on decomposition with hot water. This, however, changed the catalyst and necessitated its replacement from time to time. The efficiency of the process also suffered as its operation was thus discontinuous. Hydrolysis with water was therefore replaced by interacting the catalyst with hydrogen. The procedure finally adopted consisted in leading over the catalyst, a carefully regulated stream of active nitrogen *followed by that of hydrogen pre-subjected to electrical discharge*. The latter gas reacted with the exposed catalyst to give ammonia directly, which was readily absorbed from the effluent gases. Ammonia yields were appreciable in the cases of magnesium, cadmium, aluminium, sulphur, chromium and monazite. They were comparatively poorer with alumina, zinc, arsenic, tungsten, nickel, selenium, tin, cobalt and calcium. A marked improvement was effected by heating to about 200° C., the catalyst and also *nitrogen before activation*.

The gases were not allowed to mix; the unused portion of either of them could therefore be used over and over again. Furthermore, the activity of any of the catalysts continued unimpaired for long periods. The chief requisite for its successful performance is, that at the working temperature, the nitride formed should be unstable and reactive towards hydrogen. This is illustrated by the fact that but negligible yields of ammonia were obtained, when silicon was employed as a catalyst; its nitride is known to be exceedingly stable and unreactive.

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A. Purushotham.

Department of Chemistry,
Benares Hindu University,
October 10, 1940.

1 *Zait. Anarg. Chem.* 1905, **43**, 111.
2 *Ibid* 1908, **14**, 181.
3 *Ibid.*, 1907, **13**, 521 ; 1908, **14**, 373 ; 1910, **16**, 96.
4 *Cf.* Mellore. *Comprehensive Treatise on Inorganic and Theoretical Chemistry*, 1924, **8**, 149–51.
5 *Ibid.*, p. 84 ; Kaplan, *Proc. Nat. Acad. Sci.*, 1928, **14**, 258 ; Reyleigh, *Proc. Roy. Soc.*, 1911, **85**, 219 ; Lowry, *Inorganic Chemistry*, 1931, p. 414 ; Partington, *Inorganic Chemistry*, 1933, p. 545 ; Willey, *Collisions of the Second Kind*, 1937, p. 19.
6 *J. Amer. Chem. Soc.*, 1928, **50**, 27 ; 1929, **51**, 654.
7 *Zeit. Physikal. Chem.*, 1931, **14**, 397.

A Light Effect in Chlorine under Electrical Discharge

The marked adaptability of a Siemens' type, glass or silica ozoniser for the production of discharge reactions and especially for enabling

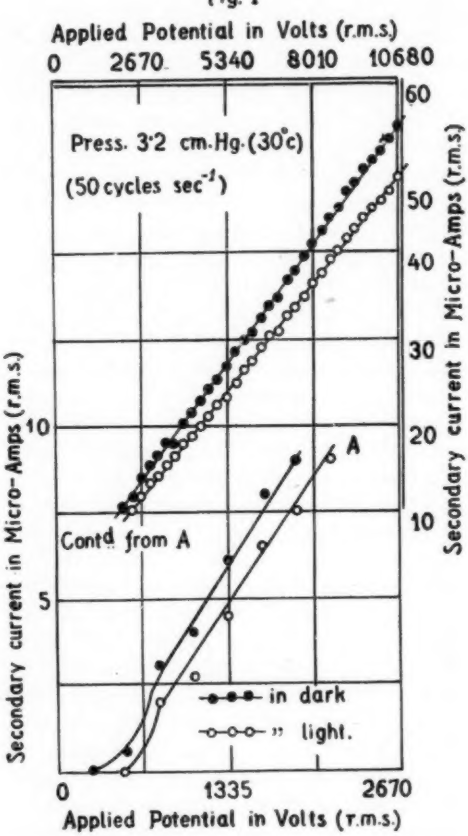
a correlation between the characteristic electrical quantities and the resultant physico-chemical effects was emphasised previously.[1] With but a small extension, the method lends itself conveniently to investigating the above phenomena under an *additional* constraint such as an external magnetic field, irradiation, etc. The inner tube enclosed by the annular space and the outer jacket surrounding the ozoniser, serve both as electrodes and light filters, when filled with an electrolyte solution appropriate to the part of the spectrum selected for irradiation.

It is observed that the *current produced at moderate pressures of chlorine in the dark, is diminished sensibly and instantaneously on exposure to light*; the effect is reversible; on shutting off the light, the discharge current returns to the original value without any lag. With the exception perhaps of a preliminary note published elsewhere,[2] this effect does not appear to have been recorded in the literature.

The phenomenon *called A* for shortness' sake, reported in the *Sci. Cong. Abst.*, refers to a *slow* 'ageing' effect, *i.e.*, the diminution with time of the discharge current at a given applied potential. In A, the recovery of the current after the discontinuation of the discharge is subject to an appreciable lag, whose magnitude depends upon the duration of the previous exposure. In A, 'ageing' is accelerated by light; it is not, however, instantaneous and shows a lag during recovery. What is now reported (called B) is an *instantaneous* effect both when it occurs under irradiation and when it recovers, on shutting it off; there is no lag during recovery in B. Furthermore, B is affected less by the frequency of the A.C. supply than A. B is very much less than A in bromine and iodine vapours; just contrary is the case with chlorine. Further work has shown that B is more analogous to the familiar 'clean up' effects than A. Some marked similarities, however, obtain between A and B, *e.g.*, in respect of the influence of the applied potential and the wavelength of the light used. It would even appear that B is part of A at any rate under certain conditions. It is considered advantageous, however, to study the two effects on a distinctive basis. The present note, therefore, avoids their premature and undue identification.

Mixtures in different proportions of hydrogen + chlorine (occurrence of this familiar photoreaction now produced under the discharge, notwithstanding) and hydrogen + hydrochloric acid gas, hydrogen being always present in excess, also showed the same phenomenon, though not

Fig. 1



so markedly as pure chlorine. In all the mixtures examined so far, the effect increases with the intensity and the frequency of the light.

It is instructive to consider this photodiminution of the discharge current from the

standpoint of V_m, the *'threshold potential'* of the system.[1,3] As V, the potential applied to the ozoniser is increased gradually, the corresponding current (also the wattage dissipated in the system) increases suddenly at V_m (*cf.* Fig. 1). This quantity also determines the setting in of a chemical reaction in the ozoniser, depending upon the pressure and especially the nature of the reactant material.[1,3] The characteristic current potential curves in Fig. 1 show that the *'threshold potential'* is increased under irradiation. It is to be anticipated therefore that the discharge current produced at a given potential V, would diminish under light, as is actually found to be the case, since it is easily shown that the current depends upon the difference $V - V_m$[1,3]. The typical curves in Fig. 1 also show what has been observed already in a large number of cases that the photo-diminution of current in the discharge increases with the magnitude of the applied potential.

An increase in the frequency of the A.C. supply, and the discharge current, a decrease in the gas pressure and the temperature of the system increase the photo-diminution.

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November 26, 1940.

1 *Curr. Sci.*, 1939, **8**, 548.
2 *Proc. Ind. Sci. Cong.*, 1940, Phys. Sec., p. 24.
3 *Trans. Farad. Soc.*, 1929, **25**, 120.

Photoelectric Efficiency of Iron, Cobalt and Nickel at Different Temperatures in the Soft X-Ray Region

Soft X-rays produced from a thoroughly outgassed target of nickel at room temperature were filtered from ions and electrons by a condenser arrangement and were then made to fall on one of four metal plates fitted into a lantern structure. The four metal targets used were of iron, cobalt, nickel and copper. The framework could be rotated by a magnetic arrangement and each of the targets could be brought successively to the position required for the incidence of soft X-rays. The entire lantern structure was thoroughly degassed before measurements were made, by electronic bombardment from a tungsten filament fixed within this structure.

The photoelectrons produced from the target were attracted by an external shield which was maintained at a potential of 54 volts higher than that of the target. Measurement of the photoelectric current was made by connecting the lantern to a quadrant electrometer and introducing between them a leakage resistance of smoked quartz having a value 10^{11} ohms.

The experiments were carried out at different temperatures of the targets ranging from 30° C. to 950° C. The pressure of the residual gas inside the experimental tube of pyrex was lower than 10^{-6} mm. of mercury as measured by a McLeod gauge.

The photoelectric sensitivity of iron for soft X-rays was found to be constant up to about 780° C. The value decreased by about 10 per cent. in the range 780° C. to 900° C. and thereafter showed a rise. The Curie point of iron is 770° ± 5° C. This temperature also corresponds to the transition point at which α-iron is converted into β-iron. The β-variety is known to be transformed into the α-variety at 910° C. The photoelectric sensitivity of iron is found to show a change at these temperatures. Cardwell[1] has studied the photoelectric sensitivity of iron in the ultra-violet region. Except for an additional inflexion which he obtains at 475° ± 50° C., there is close resemblance between his results and those in the present investigation.

This conclusion that soft X-rays show a similarity to the ultra-violet light from the point of view of photoelectric effect, receives confirmation from the experiments of Rudberg[2] who examined the velocity distribution of photoelectrons produced by soft X-rays. He found that by far the larger part of the photoelectrons had velocities corresponding to the order of a few volts.

Bandopadhyaya[3] has shown that the number (N) of photoelectrons ejected from a target bombarded by soft X-rays generated at an

applied potential V, may be expressed in form

$$N = \frac{1}{2} CK \cdot \frac{eV}{h\nu_0}$$

where C and K are constants depending on the nature of the photoelectric and soft X-ray targets respectively, e is the charge on the electron, h is Planck's constant and ν_0 the threshold frequency. It may be concluded on this basis that the changes in the photoelectric sensitivity of iron at about 780° C. and 900° C. should be due to the changes in the value of photoelectric threshold accompanying the crystalline transformation at these points.

Cobalt and nickel were found to have constant values for their photoelectric sensitivity in the range from 30° C. to 950° C. This fact shows that the photoelectric threshold is unaltered when the hexagonal close-packed structure of cobalt passes into the face-centred cubic structure at 850° C. In the case of nickel, no change of sensitivity occurs at 358° C., the Curie point of this metal. This observation confirms the previous work of Rao[4] on nickel.

Attention may be drawn to the conclusions of Hayakawa[5] who found large changes in the secondary electron emission from iron, cobalt and nickel at temperatures corresponding to their transformation and Curie points. The variation of the photoelectric sensitivity of iron with temperature in the present investigation shows no resemblance whatever to Hayakawa's observations. The results for cobalt and nickel show that there were no changes at the transformation point of 850° C. in the case of cobalt and at the Curie point (358° C.) in the case of nickel whereas Hayakawa found large changes in the secondary emission at these temperatures. Full details will be published elsewhere.

K. S. Sankarasubba Iyer.
Annamalai University,
Annamalainagar,
December 2, 1940.

1 Cardwell, *Proc. Nat. Acad. Sci.*, 1928, **14**, 439; and 1929, **15**, 544.
2 Rudberg, *Proc. Roy. Soc.* (A), 1928, **121**, 385.
3 Bandopadhyaya, *Ibid.*, 1928, **120**, 46.
4 Rao, *Ibid.*, 1937, **159**. 283.
5 Hayakawa, *Sci. Rep. Tohoku Univ.*, 1233, **22**, 934.

Oxidation of Glucose by the Plague Bacillus

Of all the compounds tested for oxidation by the plague bacillus (*Pasteurella pestis*), glucose is oxidised at the highest rate.[1] A detailed study of this oxidation is, therefore, interesting. Some quantitative experiments on the oxidation of glucose by suspensions of the bacillus will be of interest to those working on the intermediary carbohydrate metabolism of bacteria. It was found that the amount of oxygen required to oxidise to completion a given quantity of glucose depended on the previous treatment of the bacteria. The oxidation to completion of added glucose was measured in the presence of air in Warburg manometers at 27° C. The glucose (0·5 or 1·0 mg.) was added to an excess of bacteria (25 mg. dry weight) per vessel suspended in phosphate-buffer at pH 7·4, and the oxygen uptake recorded until it had fallen to the same rate as in the control containing the bacterial suspension only. This occurred in 3 to 4 hours. The experiment showed that for a freshly prepared suspension, which had not been washed extensively on the centrifuge, the oxidation of 1 mol of glucose requires exactly 4 mols of oxygen. The method followed in the preparation of this suspension was to wash off the bacteria grown on agar in Roux bottles into saline or phosphate-buffer and to centrifuge. The bacteria are sedimented while the supernatant contains most of the broth constituents dissolved out of the agar. The sediment was re-suspended in fresh saline or buffer and used at once. However, if all traces of metabolites from the suspension have to be removed, the washing on the centrifuge has to be repeated several times and the suspension left for some time, preferably in the refrigerator (2–4° C.) overnight, so that part of the metabolites stored in the cells may be used up. A suspension treated thus requires 2 mols of oxygen for the oxidation of 1 mol of glucose. If the bacteria are grown as described but with the addition of 2 per cent. glucose to the agar an entirely different oxidation ratio is

observed; the oxidation of 1 mol glucose then requires 1 mol of oxygen only. This variability may be tentatively explained by assuming that the presence of glucose during growth, or the extensive washing to which the bacteria are submitted, uses up or removes important links in the chain of oxidation-reductions present in the cell or in the medium, which may conceivably be coenzymes or other hydrogen-carriers. It has already been shown that co-zymase, nicotinic acid and thiamin (Vitamin B_1) catalytically stimulate the oxidation of glucose by these bacteria.[2] Detailed experiments to test this hypothesis by adding the better known coenzymes including the above, however, failed to restore the system fully to the original state.

The detailed manometric study of the oxidation of glucose by the freshly prepared suspension shows clearly that the entire process consists of short steps succeeding each other. Some of these steps may fail to occur in the absence of the corresponding coenzymes. For this purpose the oxygen uptake on adding glucose was measured simultaneously with the carbon dioxide produced with bacteria suspended in phosphate and shaken in air, while the glycolysis (acid-production) was measured with bacteria suspended in 0·025 M. $NaHCO_3$ instead of phosphate and shaken in a mixture of 5 per cent CO_2 in air. Parellel manometers were run containing the corresponding controls. The curves thus obtained for the entire reaction can be divided into three steps, the time relations of which vary a little from one experiment to another. In the first step, lasting usually from the beginning of the reaction to the 30th minute, 2 mols of oxygen are taken up while 1 mol of carbon dioxide and 2 mols (equivalents) of acid are produced. In the second step, from the 30th to about the 80th minute, 1 mol of oxygen is further taken up while 1 mol acid disappears and 1 mol carbon dioxide is produced. In the third and last step another mol of acid disappears and one more mol of oxygen is taken up. The production of acid is thus transitory.

Incidentally the bearing of these results on the technique of fermentation tests employed for the identification of pure cultures of bacteria is important. In these tests the bacteria are inoculated into a test-tube of broth or peptone-water containing the carbohydrate to be tested and an indicator such as phenol red. During the growth of the organism if the carbohydrate is fermented (*i.e.*, acid is produced) the indicator changes colour. Since the conditions in the medium are not fully anærobic part of the acid accumulating may be oxidised by molecular oxygen. If the rate of attack of the carbohydrate is slow while the rate of oxidation of the intermediate organic acid is faster no fermentation reaction will be recorded. Lactic and acetic acids which are most likely to be formed as intermediates are oxidised much more rapidly by the plague bacillus than the pentose sugars.[1] This may explain the discordant results obtained by different workers on the fermentation of arabinose, rhamnose, xylose, dulcitol, etc., by the plague bacillus.

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November 28, 1940.

[1] M. S. Rao, *Ind. Jour. Med. Res.*, 1939, **27**, 617.
[2] —, *Ibid.*, 1940, **27**, 833.

Water Pollution by Distillery Waste

It is observed that when a distillery waste mixes with a river or other flowing water, an offensive smell develops in the lower reaches of the water. A sample of the Halla water at Mandya into which the distillery spent wash flows, showed the presence of 3·4 parts of H_2S per 100,000 (by iodimetric estimation) with the accompanying odour after a storage of 5 days, whereas there was absence of the gas on the first day.

To determine the cause, the spent wash was analysed and gave sp. gr. 1·036/25° C., solids

on evaporation and drying at 100–110° C.—6·0 to 7·0 per cent.; ash—1·64 per cent.; yeast centrifuged 0·75 per cent.; potash 0·7 per cent.; sulphur, present in sulphate 0·098 to 0·13 per cent. The spent wash diluted 1 : 1 or 1 : 2 was clarified with 2 per cent. lime which precipitated most of the yeast and colloids. The precipitate dried at 110°–120° weighed 2·5 per cent. and the ash was 1·05 per cent. The dry precipitate on acidification with HCl gave off CO_2 and no H_2S. The clear filtrate passed through sand was not free of yeast, but when passed through a Seitz filter, was free from all yeast and bacteria. Solids on evaporation of the latter filtrate, dried at 110° C., weighed 4·8 per cent. of the spent wash and on acidification with HCl gave off H_2 and H_2S. Igniting the solids gave ash—1·6 per cent. in which Fe ·0008 per cent., CaO 0·83 per cent., K_2O 0·77 per cent., and sulphide, estimated by liberating H_2S and iodimetric titration, as S ·03 parts per 100,000 of the spent wash.

In practice, sulphitation cane molasses is diluted 1 : 5 with water and acidified with sulphuric acid to pH 4·5 and a vigorous stream of air passed through the liquid to ensure quick dilution. Calcium sulphite, $CaSO_3$, present in molasses is thereby converted to sulphate and much of the gas SO_2 escapes. After fermentation with *S. Cerevisiæ*, the wash is fed to the Analyser and steam is passed up the column. Alcohol vapours, with the small quantity of dissolved SO_2, pass to the Rectifier from the top of which uncondensed gases escape to the air. The spent wash leaves from the bottom of the Analyser. Daily a quantity of 25,000 gallons of spent wash flows into the Halla where it may be diluted with 200 to 300 times its volume of canal water. The quantity of water flowing in the Halla varies greatly with the season and the offensive odour is either strong or negligible accordingly.

The detection of sulphide in the spent wash lends support to the observation by Tanner[1] of sulphate reduction by the reducing enzymes in yeast. A further interesting observation was made at Mandya when the top section of the Analyser colum was dismantled after five years' working. There were a few hundred grams of a pulpy black deposit on the plates above the feed plate. The deposit appeared like free carbon and easily dropped off the plates. It analysed Cu 66·5 per cent. and S 33·5 per cent. and is thus found to be Cupric sulphide. Apparently free H_2S liberated from the wash, reacting with the hot copper plates at 80°–85° C., produced the sulphide. This confirms the observation of sulphate reduction by the yeast reductase to hydrogen sulphide. Thus the yeast from the spent wash depositing in the watercourse, continues sulphate reduction with production of the offensive odour of H_2S, concentration of which depends on the quantity of water flowing in the Halla. Sulphur reducing bacteria are apparently a contributory cause as there is a development of odour when sulphite containing waste water from the factory is allowed to stand a few days.

To avoid water pollution by the gas, H_2S, the suggested measure is to remove the yeast, partly by centrifuging the wash before feeding into the still and then to precipitate the residual yeast in spent wash, with lime and subsequent filtration. The economy of this procedure has to be studied in each case.

Y. K. Raghunatha Rao.

Distillery,
Mysore Sugar Co., Ltd.,
Mandya,
November 12, 1940.

1 Tanner, F. W., *J. Amer. Chem. Soc.*, 1918, **60**, 663.

[Since the above note was written the Analyser plates were taken out and it has been found that the comb-slit bubbling cups of three plates, directly above the feed plate, have been so much acted upon that the 3/12" thick metal has become thin as paper and torn out of shape especially at the slit edges at which the hydrogen sulphide carrying alcohol-vapours turn down and bubble up through the condensed liquid. The copper sulphide deposits on the plates, which are comparatively uncorroded. The acids, in the vapours or entrained with the wash, including sulphuric acid, probably give rise to a soluble salt in contact with the hot

metal and then the copper sulphide is precipitated. This black precipitate is also found at the bottom plates of the Rectifier, and occasionally is drawn out with the lower oils. Y. K. R.]

The Influence of Light on the Germination of Species of *Striga*

SEVERAL workers have observed the high degree of variability exhibited by phanerogamic parasites and it would appear that species of *Striga* are no exception.

In the Botanical Section of the Poona Agricultural College, investigations upon three species of *Striga* that attack *jowar* (*Andropogon sorghum*) namely *S. lutea*, *S. densiflora* and *S. euphrasioides* have been in progress for some time. In the beginning, it was noticed that the first two species required the presence of the host for germination, whereas the third did not. In attempting to germinate the seeds of these three species in petri dishes exposed to light during daytime it was found that *S. lutea* showed some germination, *S. densiflora* gave very little germination and in the case of *S. euphrasioides* the percentage of germination was higher without than with the presence of the host. In order to induce better germination of *S. densiflora*, it was decided to try the effect of keeping the dishes in a dark chamber. Surprisingly, the result was that the seeds of the parasite showed a much higher percentage of germination when kept in darkness. The reaction of all the three species to light and darkness was, therefore, tested with still more interesting results. A typical set of results is tabulated below. The seed of a highly susceptible variety of Sorghum was used in the test.

Species	No. of dishes tested	Treatment	Percentage germination per dish	
			Range	Mean
S. lutea ..	50	Light	0–52	16·3
,, ..	50	Dark	0–73	38·4
S. densiflora ..	45	Light	0–11	1·5
,, ..	41	Dark	0–14·2	4·4
S. euphrasioides	50	Without host-Light	11·4–83·1	44·4
,, ..	50	With host-Light	0–64·3	32·6
,, ..	50	Without host-Dark	0–16·1	3·5
,, ..	50	With host-Dark	0–32·7	9·1

A word of explanation is perhaps necessary to account for the high range of variation in the results. This must be ascribed to three reasons (*a*) the progressive maturation of the seeds which is a characteristic of many of the phanerogamic parasites, (*b*) the inherent variation in the capacity of the host seed to induce germination of the parasite seeds, and (*c*) other causes controlling germination which have not been determined.

From the results it will be observed that *S. lutea* germinates about 100 per cent. better in the dark than in light. *S. densiflora* shows a higher percentage of germination in the dark though the germination is still unsatisfactory. In *S. euphrasioides*, the germination in the light is very much higher than in the dark; but whereas, with host, in the light a lower percentage of germination than without host is observed, in the dark the converse holds good.

It is not possible, at this stage, to explain this peculiar behaviour to light of the seeds of these three species of *Striga*, but it is hoped to throw more light on the problem as the work progresses.

The investigations were carried out under the grant sanctioned by the Imperial Council of Agricultural Research, Delhi.

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November 6, 1940.

Tetraploid Til (*Sesamum orientale* L.) from Colchicine Treatment

EXPERIMENTS for inducing polyploidy in Sesame (*Sesamum orientale* L.) by using colchicine have been in progress at the Oil Seeds Research Laboratory, Nagpur, since June 1938. After numerous trials we succeeded in obtaining a few tetraploid plants a short account of which is given here. A detailed account will appear elsewhere.

FIG. 2 Tetraploid Sesam — FIG. 1 Deploid Sesam

Three methods of treatments were used:—(1) Seeds were immersed in the colchicine solutions for different periods; (2) Seeds were allowed to germinate on blotting papers soaked in different concentrations of the solution; (3) Young flower buds were immersed into test tubes filled with different solutions for various periods. In all these experiments the materials were thoroughly washed after each treatment.

Seven abnormal plants out of a 100 seeds treated were noted only in the first treatment with 0·06 per cent. colchicine treated for 2 hours. These seedlings could be recognised by their swollen hypocotyls, thick cotyledonous leaves and short stunted roots. They developed into plants which appeared shorter, stiffer and thicker stemmed than the diploid. The leaves were coarse, dark-green, broad and thick.

Chromosome counts were made at meiosis from one of the plants only which has clearly demonstrated that it is a tetraploid with $n = 26$, the chromosome number in the diploid being $n = 13$. Being an auto-tetraploid 0–5 tetravalents are formed at meiosis.

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Nagpur,
October 31, 1940.

The Inheritance and Linkage Affinities of the Yellow Coloured Midrib in Sorghum

THE colour of the midrib in sorghum is white, if the stalk is pithy; it is dull green if the stalk is juicy. The former is a monogenic dominant to the latter.[2] The occurrence of midribs brownish purple in colour, due to the mechanical tissues being coloured brownish purple, has been recorded as a monogenic recessive.[3] The midrib could also be coloured yellow. Vinall, Stephens and Martin[5] recorded its occurrence among milos. In his tabulated list of sorghum characters Martin[1] has noted the yellow midrib as dominant to non-yellow.

At the Millets Breeding Station, Coimbatore, it has been noted that this character of yellow midrib occurs in 59 types. The distribution shows that it could occur in most varietal groups. There is naturally a larger number in the groups with numerically more types, about ten each in the three common species—*S. durra*, *S. subglabrescens* and *S. nervosum*. Yellow midribs occur in both pithy and juicy stalked varieties. Of the 59 types in which they were met with, it is noteworthy that 38 had blackish purple leaf-sheaths (PPqq).[4]

The yellow colour in the midrib is seen even in young plants a month old. It is prominent in the top leaves, and in the lower ones visible at the bases of the leaves. In full grown plants it is best seen in the top leaves at flowering time. If a leaf is cut and dried, the colour persists. The yellow colour is due to the presence of a carotinoid pigment in the sclerenchymatous tissues at the upper and lower surfaces of the midrib.

To study the inheritance of this character and its affinities to juiciness and leaf-sheath colour, crosses were made between two parents A.S. 3897 (yellow midrib, pithy stem and blackish purple leaf-sheath) and A.S. 3835 (dull green midrib, juicy stem and reddish purple leaf-sheath). The F_1 had yellow midrib, pithy stem and reddish purple leaf-sheath. In the F_2 generation four families were raised and the following segregation occurred:--

Stalk ..	Pithy		Juicy	
Midrib colour..	Yellow	Non-yellow	Yellow	Non-yellow
Total of 4 families	331	109	117	39
Calculated 9 : 3 : 3 : 1 :	335	112	112	37

It is evident that the above is a normal dihybrid distribution, the yellow midrib being independent of the stalk being pithy or juicy.

The segregations for leaf-sheath colour and yellow midrib colour pair of characters are given in the following table:—

Leaf sheath colour ..	Reddish purple		Blackish purple	
Midrib colour ..	Yellow	Non-yellow	Yellow	Non-yellow
A.S. 6558 ..	87	30	28	5
A.S. 6559 ..	87	36	37	4
A.S. 6560 ..	73	31	27	4
A.S. 6561 ..	80	34	29	4
Total ..	327	131	121	17

It is obvious from the above figures that there has been a disturbance of the normal dihybrid segregation. Assuming linkage between the genes for yellow colour of the midrib and leaf-sheath colour, in the repulsion phase, a crossover value of 35·5 per cent. is obtained for the above distribution. The expected distribution on this assumption is as follows:—

Leaf sheath colour ..	Reddish purple		Blackish purple	
Midrib colour ..	Yellow	Non-yellow	Yellow	Non-yellow
Actual	327	131	121	17
Calculated (35·5% crossover)	317	130	130	19

$X^2 = 1 \cdot 2$, $P > \cdot 05$.

To sum up: sorghums with midribs coloured yellow occur rarely in almost all varieties. The gene for this yellow colour has been designed Y_{md}. Y_{md} is a monogenic dominant to y_{md} (non-yellow). Y_{md} is independent of D, the gene for pithy stalk. It is linked with Q, the gene for reddish purple leaf-sheath colour, with a crossover percentage of 35·5.

G. N. Rangaswami Ayyangar.

M. A. Sankara Ayyar.

Agricultural Research Institute,
Coimbatore,

November 23, 1940.

[1] Martin, J. H., *U. S. Dept. Agric. Year Book*, 1936, p. 554.

[2] Rangaswami Ayyangar, G. N., *Madras Agric. Jour.*, 1935, **23**, 350.

[3] —, and Nambiar, A. K., *Indian J. Agric. Sci.*, 1936, **6**, 481.

[4] —, *et al.*, *Ibid.*, 1933, **3**, 589.

[5] Vinall, H. N., Stephens, J. C., and Martin, J. H., *U. S. Dept. Agric. Tech. Bull.* No. 506, 1936, p. 31.

Trichogramma minutum Riley, in Relation to *Sitotroga cerealella* Ol. in Mysore

Ever since the potentialities of *Trichogramma minutum Riley*, a well-known Hymenopterous egg-parasite, in the field of biological control of certain types of harmful insect pests of cultivated crops, were discovered, the eggs of the tiny grain moth, *Sitotroga cerealella* Ol. common over a large part of the world, have been in use, principally in U.S.A. for the mass rearing of the parasite in the laboratory before liberation of the latter in infested fields.

When experiments were first started in Bangalore about a decade ago to test the suitability of different insects, to act as laboratory hosts for the mass production of *Trichogramma minutum* Riley, found to parasitise the egg masses of the principal moth-borers of young sugarcane in Mysore State, the grain moth, *Sitotroga cerealella* Ol., was, for obvious reasons, one of the locally occurring insects whose eggs were exposed to the action of the parasite. It was found, at the time, that the parasite persistently refused to take to those eggs. It was not possible to explain this curious fact and further attempts were not made.

Attempts were, however, renewed recently, and now the parasite is found to accept the same host eggs that once proved to be unacceptable. Some 24 generations of the parasite were bred out of the eggs of *Sitotroga cerealella* deriving a slightly different biological strain of the parasite.

Before an explanation of this behaviour in host preference on the part of the indigenous race of the egg parasite, *Trichogramma minutum* Riley, is put forward, it is thought advisable to make further observations. In the meantime the fact that the eggs of *Sitotroga cerealella* Ol. were definitely acceptable here to the sugarcane moth-borer egg-parasite, for breeding and multiplication, on however small a scale, requires to be recorded.

Whether the same host eggs (*S. cerealella*) will serve in India, quite as well and on as large a scale, as in U.S.A. and other places, for purposes of mass production of the parasite and whether they can successfully compete with, or prove better than, the eggs of *Corcyra cephalonica* St. at present in extensive use, as the host, in the parasite laboratory at Mandya in Mysore State, is quite another matter, requiring further investigation.

B. Krishnamurti.

Department of Agriculture,
Bangalore,
November 20, 1940.

A Meteor

A most extraordinary meteorological phenomenon occurred at about 9-20 on the night of the 7th September 1940. A meteorite of unusual size and brilliance shot across the sky right overhead of us from east to west throwing out sparks of white light in profusion on either side of its dazzling trail, paling the electric lights all round for a few seconds. It appeared to come down in a big curve, and as it neared the horizon, its head turned reddish and the streak behind, bluish green. There was a thud like that of distant gunfire and a low roar for about a minute. The phenomenon was distinctly visible at several stations in the district, as I have been informed. Even people enjoying a circus show at Beawar, 32 miles S.W. of Ajmer, were attracted by this exciting object, and hundreds living in the open, in a Famine Relief Camp saw it. All declare that they never saw the like of it in all their life. Probably some of the villagers in Marwar living on the borders of Ajmer-Merwara, will be able to locate it.

A. N. David.

Husband Memorial High School,
Ajmer,
November 23, 1940.

REVIEWS

Concise General Astronomy. By O. R. Walkey and H. Subramania Aiyar. (Sridhara Printing House, Trivandrum), 1940. Pp. 442. Price Rs. 5–8–0.

Popular works on Astronomy published in India are very rare. Probably there is none. If so the present work is a pioneer in the field, and is to be warmly welcomed on that account. Its special feature, and in our opinion, its most valuable feature is the very interesting information it contains about Hindu Astronomy, and the incorporation of this information in a general scheme gives one a proper perspective regarding the achievements of Hindu Astronomy. The first three appendices make, from this point of view, fascinating reading indeed.

The other appendices contain information on such diverse topics as Arabian, Chinese and Egyptian lunar mansions, sundial design and map-projections, all subjects of a practical interest. The several tables brought together in one place from a large number of sources and arranged in a definite order are bound to be of great value even to those who are not merely "laymen". It would have been better if the source of information had been indicated in each table, for in this rapidly growing subject new data supplant the old ones with astonishing quickness. One is, however, constrained to say that the star maps on pages 414 and 415 are very bad, indeed the second map definitely disfigures the page.

The book proper consists of twenty-seven chapters, three of an introductory and historical nature, nine devoted to the solar system and the remaining fifteen to the study of stellar systems. Four out of these fifteen chapters give descriptions of the several constellations, and will be found to be of great use to amateur sky-gazers. The authors have taken pains to be up-to-date in the information on the several topics dealt with in the book. As examples in point we might mention the Lyot device for solar coronal observations, the number of satellites of Jupiter, the elements of Pluto's orbit, the mention of supernovæ, galactic rotation, the local cluster, Trumpler's stars. the physical constitution of planetary atmospheres and several other data regarding galactic and extra-galactic nebulæ and star clusters. The book is an accurate and reliable guide to the lay reader in understanding the great developments in Astronomy that have taken place in recent years on the observational side. The numerous facts and figures are arranged clearly and succinctly, and presented in a racy and vigorous style, highly reminiscent of a popular evening lecture.

This idea of the popular appeal has throughout been kept in the forefront in the book, but, we are afraid, it is a little overdone. One such instance is the rather too frequent reference to the Creator whose aid is invoked even on occasions when it is not quite imperative. Thus, for example, the authors remark on p. 205 that the source of stellar energy cannot be accounted for on any known laws, and one has only to acknowledge the direct interposition of the Creator. In view of the recent work of Bethe and Gamow on the nuclear theory of stellar energy, it is difficult to justify such a stand. Even from a general point of view, such an attitude spells an air of superficiality about it and appears out of place in a book which is entitled as a *Concise General Astronomy*, and which is scientifically accurate in the details of the subject it gives.

Nor are the references to the theory of relativity quite happy. It is unfortunate that the book should contain a sort of a contemptuous reference to the "mathematician's square-root-of-a-negative quantity and purely imaginary concept of some fourth or other inside-out dimensional existence", for this gives an entirely erroneous impression that the concept of time in relativity is purely imaginary. The reference to "a mathematical explanation of the sudden disappearances of angelic beings after delivering their messages" (p. 51) is unworthy of a place in a scientific book on general astronomy. Also the relativistic explanation in §295 of the meeting of two bodies as meaning the agreement in their space and time co-ordinates is definitely wrong since it contradicts the relativity of simultaneity as can be shown by considering the Lorentz transformation. We consider it an error of discrimination on the part of the authors to mention (p. 280) Sulaiman's

theory as an alternative to the theory of relativity without taking the trouble of examining the foundations of the former theory.

In the Preface to the book, we are duly warned against the "desertion of the standard of Science for the banner of speculation, often Science, falsely so called", and against placing implicit faith in Mathematics, the intellectual barrel-organ. We must, however, confess that the book itself abounds in speculation of a mystical nature. We must also protest against the book ending in a "Dream". The aim of a book on Astronomy ought to be the instilling of a scientific curiosity in the reader, and a wide-awakenness to the problems which still challenge a solution.

Apart from these criticisms of a general nature, we must admit that the book gives a valuable account of the advances in modern astronomy and is eminently readable. We wish it many more editions quite soon.

B. S. MADHAVA RAO.

Atoms in Action (The World of Creative Physics). By George Russell Harrison. (George Allen & Unwin, Ltd., London), 1940. Pp. 370. Price 12*sh*. 6*d*. net.

Much of the material presented in this book formed the basis of a series of Lowell Lectures entitled "Modern Physics and Human Welfare" given by Professor Russell in Boston. Some of his contributions to *The Atlantic Monthly, Harper's Magazine, The Scientific American* and the *Technology Review* have also been used in writing various chapters. When the American Institute of Physics suggested to Professor Russell the desirability of putting all these labours in the form of a book, it is no wonder that the author took nearly two and a half years in sifting and collating his material. The result is this fascinating book. As a physicist who has done considerable work in the field of spectrum photometry and spectrum analysis, he has presented in the book an extremely interesting picture of the diverse ways in which the recent advances in the world of atoms cross the paths of human civilization, in an easy style so as to be understood by the wider public interested in scientific themes.

The aim of the author in writing this book is set forth in these words "Almost every material problem of living turns out in the last analysis to be a problem of the control of energy. The wheels of civilization are kept turning by energy; and all this energy, whether we draw it from a gallon of gasolene, a ton of coal, or a pound of butter, has come to us from the sun. Energy is wealth, and in the case of apprenticed sunlight, wealth of a particularly desirable kind, for it is freshly created, free to him who can discover how to capture and control it". In the sixteen chapters of which the book is composed, the central theme "How energy is used" has been fairly comprehensively treated in practically every aspect in which man has utilised this "Spirit" of physical science. All the chapters have popular and arresting titles (Starting with "The Taming of Energy" to "The End is not Yet") and are provided with apt quotations somewhat in the Waverly fashion. It has the rich and wholesome atmosphere of a banquet about it, and the promised fare will satisfy the most epicurean appetite. The reader is taken through a wonderful field of the achievements of physics, which man has used for his cultural pleasure and material profit, and few readers will miss the delight of enjoying the vivid and impressive pictures portraying the power of the principles of physics in directing and controlling human activities. The chapters "The Ransomed Electron, Sound Borrows Wings, Eyes for the Memory and Sight Conquers Space" are of absorbing interest and the other chapters are written with the same clarifying force and imaginative insight. Those who wish for a generous and deeper understanding of some of the marvellous creations of science, Radio-telephony, Colour photography and so forth, will find in "Atoms in Action" every information they may desire. It is one of the very few books in its line, which is at once authoritative and entertaining, and in both respects, it constitutes a valuable contribution to modern scientific literature.

Chemistry, Life and Civilization (A Popular Account of Modern Advances in Chemistry). By Hubert T. S. Britton. (Chapman & Hall, London), 1940. Pp. vi + 266. Price 5*sh*.

This book is well written, well got up and well illustrated. The type is bold and gratifying to the eye. The matter dealt with, it need scarcely be said, is of vital importance. Human Society is at bottom chemical, and it progresses by the advancement of

researches in the physical sciences. There is hardly any phase of human activity,—politics and statistics excepted,—which has not been influenced and made better by the improvements in chemical technique and processes in industries.

The author has used an easy language and an elegant style in the presentation of the subject matter. For the benefit of those who may not possess a previous knowledge of chemistry, the general principles of the science are treated in a way which any intelligent person can easily follow. Having equipped the general reader with this preliminary acquaintance, the author takes him from Chapter VI on through a wonderland of achievements which have a tonicic effect on the intellectual appetite. Chemistry has added to the richness of the enjoyment of life, its gifts have also been prostituted, undermining the very civilization they have helped to build. Before the advent of science, the world was a great puzzle and the progress of scientific knowledge has solved a great many riddles and incidentally has materially tended to make life comfortable and civilized. The book reveals the processes by which human advancement has been accomplished, and should therefore present irresistible attraction not only to the inquisitive youngmen, but also to the older generation of the reading public, endowed with the spirit of enquiring into the "how" and "wherefore" of things by which they are surrounded. We have no doubt that there are few books in the field which offer so much interest and so much information as Professor Britton's work. There is a short supplement in which the author gives an account of the latest advances in our knowledge of vitamins, new drugs of the sulphanilamide group, protamine insulin, synthetic rubber, artificial wool and artificial silk. We have a fairly complete picture of the romance of chemistry in relation to human life and civilization.

Biology in the Making. By Emily Eveleth Snyder. (McGraw-Hill Publishing Co., Ltd., London), 1940. Pp. x + 519. Price 18 *sh.* net.

Undoubtedly students of General Biology and those of Medicine will be profoundly grateful to the author for placing in their hands a book at once eminently useful and extremely interesting. The author has adopted a new line of treatment. She has selected twenty-one biological topics practically covering the field of study pursued by medical students and others following a general course, and, under each subject, she has given a lucid description of the principal facts and short biographical sketches of the scientists who made the new discoveries, thus clothing the scientific treatise with a human interest. "The purpose of the book is to trace the development of biological discoveries, not as so many facts, but as the product of real men whose lives for one reason or another made them outstanding in other fields." The author has succeeded in her task, and the simple style she has adopted makes the reading of each chapter a matter of great pleasure. It must not be supposed, however, that the book attempts to exhaust the field, nor does each chapter comprehend all that could be said under each topic. For instance, the chapter on "Chemical Messengers" makes no reference to the pituitary gland to which, however, there is a passing reference in the chapter on Calories and Vitamins (p. 344); "Learning from Fossils": this is decidedly a poor and incomplete chapter; Cuvier and Agassiz have an interest, but the modern discoveries must have a deeper interest and significance to the study of biology. Consistent with the aim of the book, principally to serve the needs of students, the subjects are adequately and admirably treated. It follows the excellent traditions of modern scientific works in providing at the end of each chapter a list of other books for further reading, profuse illustrations of leading scientists, a general bibliography, glossary, chronological list of scientists, and an ample index. The book leaves nothing to be desired, and it will be widely welcomed not only by students, but by the general reading public. We congratulate the author and the publishers on this stimulating and interesting book, whose style is as attractive and simple as the matter dealt with is informing and useful.

A Text-Book on Crystal Physics. By W. A. Wooster. (Cambridge University Press, London), 1938. Pp. xxii + 295. Price 15*sh.*

The discovery of the diffraction of X-rays by crystals provided the physicist with a powerful method for the analysis of crystal structures, and during the last twenty-five years he has been accumulating, at a rapid

rate, data concerning crystal structures, of great importance to both Physics and Chemistry. While engaged in this new work it was only natural that other aspects of crystal work, as for example, the explanation of the various properties of crystals in terms of their fine structures as revealed by the X-ray studies, did not engage sufficiently the attention of the physicist. In some of the recent work on crystals, however, one can see a definite reaction against this overmuch emphasis on structural problems, and a swing back of the pendulum towards problems concerning the real physics of crystals. As illustrations, we may refer to the detailed investigations both theoretical and experimental, that have been made on the optical, dielectric, magnetic, and other properties of simple ionic and molecular crystals, and on the properties of metals and alloys, in relation to their structures. The publication of Wooster's book is an expression of this swing back towards crystal physics, and to one who reads the book with the background of our accumulated knowledge of the results of the X-ray studies, the book serves as a gentle reminder of the neglect in which we have allowed the subject to remain.

Within the compass of less than 300 pages of large type, the author has managed to bring together the important results of crystal physics. The need for a book of this kind in English has indeed been felt for some time. A striking, and probably desirable, feature of the book is the use of the tensor notation throughout, which is very convenient in the treatment of the directional properties of crystals. The chapters on electric and magnetic induction, and on piezo-electricity, are well-written, and in particular the chapter on crystal optics, in which many little points that trouble the new-comer to the field, and are not properly dealt with in the ordinary text-books, are treated adequately. One wishes that an account had been included of the luminescence phenomena in crystals, which have been studied extensively during recent years. One also wishes that the diffraction of light by crystals in which are impressed ultrasonic waves, had been treated in greater detail, in relation to the determination of the elastic coefficients of the crystals, and a short account had been given of light-scattering in crystals. In the chapter on induction, though the diamagnetic crystals are treated at some length, the paramagnetic crystals are dismissed with just one paragraph. (The formulæ at the bottom of p. 100, and the statements immediately preceding them, are correct only when a_c is large. Quaterphenyl is misprinted twice as quarterphenyl.)

The publication of this book should be particularly welcome to Indian students, since no systematic teaching of crystal physics, as far as the reviewer is aware, is given in any of the Indian Universities.

K. S. KRISHNAN.

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1. **Poisons**. Their isolation and identification. By Frank Bamford. (J. & A. Churchill, Ltd., London), 1940. Pp. 344. Price 18*sh*.
2. **Forensic Chemistry**. By Henry T. F. Rhodes. (Chapman & Hall, Ltd., London), 1940. Pp. 214. Price 12*sh*. 6*d*.

Text-books on the subject of medicolegal chemistry are so rare that one welcomes any book bearing on the subject. The average chemist, who is engaged in detecting poisons for legal purposes is quite often driven to following a "hit or miss" method in the absence of adequate and accurate information regarding the mode of administration of poisons, the clinical and pathological symptoms and interval for such symptoms to appear, and the sequealæ-recovery, or death,—or other permanent residual effects, following the administration of such poisons. As is legally required in this country, the police subject all cases of suspicious death, (even paupers dead of starvation, accidental deaths, and all such cases where they feel that there is not sufficient evidence of the cause of death) to chemical examination; this necessitates the undertaking of expensive time-consuming analyses. Any relief or short cut given in this direction is very welcome indeed. The above two books cannot be said to give all the necessary and available information but represent two distinct approaches to the rather vague and ill-defined subject of Forensic Chemistry, and are in a sense supplementary to each other; both the books have made available information not always readily obtainable. One, however, longs for a complete modern text-book on the subject of medicolegal chemistry, but, this as yet is not to be!

1. Bamford's book comes well recommended. Prof. Sydney Smith, who will be

remembered by all the older medical men of this country, who have taken their final medical examinations at Edinburgh, writes a foreword to the book.

The book begins with a section on the practical equipment of a medicolegal laboratory. A considerable portion of the book is devoted to the detection of inorganic and metallic poisons. While this is in no way very new, and can be readily obtained from a standard modern text-book on Inorganic Analytical Chemistry, it has included the detection of metallic poisons by colour reactions involving extremely minute quantities of such metals by reagents which have come into recent use.

An extremely useful feature of the book is the effort to systematise the analysis for the detection of the presence of alkaloidal poisons. The various alkaloids are well classified and the usual reactions given by them are listed so as to be easily available for reference. The most useful part of the book is the section on the Stas-Otto process so necessary to be carried out in all cases of suspected poisoning; in this process one seeks to extract as far as possible in an unchanged condition, the poison which caused death. The process is tedious and it is possible to miss the poison altogether, unless great care is taken at each stage of the process. Bamford seems to be thoroughly conversant with the process and the various mistakes that one is likely to commit; he has given a very lucid account of its involved technique; it is an eminently practical account and deserves to be memorised in all its details by every medico-legal chemist.

It is regrettable, however, that the book will have only a limited appeal to the Indian student, as the poisons common in India are not treated in any very great detail. Dhatura, one of the commonest poisons in India is shelved to a second place along with Atropa Belladonna; some of the very common abortifacients, used all over India are not mentioned at all. Opium, and all its derivatives have been treated with great care; the myth that Smyrna Opium and Indian Opium can be easily distinguished, is exploded. Hashish, possibly so commonly used in Egypt, has been given all the importance, the subject deserves. The toxalbumins derived from the various irritants, like castor seeds, etc., have been uncritically mentioned on the authority of the Madras Chemical Analyser's Report. The difficulty experienced by a chemist in the analysis of the contents of the alimentary system of a child, dead or suffering from an overdose of a purgative oil (commonly sold, under various trade names, in all bazaars), containing a number of substances, chief of which would be croton and castor oils, along with various irritants like aloes, etc., is so great, that it is not possible to distinguish, much less easy to estimate, the number of substances present or to certify as to which was the essential irritant factor; nor can much information be derived regarding such irritants by the performance of the agglutination test, as given in the text (details of which have been very meagerly given). The habit of betel chewing is discussed with the usual good-natured contempt of a habit to which a westerner is not accustomed. There is a great amount of misunderstanding about this rather pleasant æsthetic habit; the average easterner eats a good deal of soft food which he swallows without much mastication; the spices mixed with arecanut produce enough salivation to mix with the food in the stomach; soft food leaves residues in the crevices of the teeth which later undergo decomposition and produce halitosis (fetor about the mouth), betel nut chewing removes the soft residues; this habit also allows of a greater amount of calcium intake (most of which is excreted). One cannot, however, speak with enthusiasm on the indulgence of this habit at all times of the day, with or without tobacco. (Oral cancer has been attributed to the irritant action of calcium.) The unpleasant symptoms associated with arecanut alkaloid is only with reference to uncured nut and not with boiled well prepared nut.

The section of glycosides may well be enlarged in the next edition, specially with reference to the obtaining of active principles from the gummy residues obtained towards the end the Stas-Otto process; this has always been a great difficulty in the path of the chemist. A section on animal experimentation with the poisons isolated, may well be added to the book to make it more useful. The book has a very good author index as also a good subject index.

2. Rhodes's book on FORENSIC CHEMISTRY contains an extremely useful section on stains and how to identify them; details regarding technique to be adopted in individual cases are also given; but the examination of seminal stains is dismissed rather summarily.

No other book has given such a wealth of detail regarding the examination of inks—both writing and printing inks,—the importance of this information so well gathered together, can only be realised by a chemist who has to examine forged notes or cheques or questionable legal documents. Chemical examination of paper, chemical examination of inks, so many of which are available in the market, the pH of ink, age changes produced in ink by oxidative processes have all been well discussed that one is very grateful to the author for making such information available to the chemist. Unfortunately no one seems to have, as yet, handled the subject of inks prepared from vegetable sources, and the changes produced on them by age, chemicals, etc. This would be very useful in India where vegetable inks are used even now in rural parts. The section on counterfeit money is good and will be found useful by those who have to perform such analyses.

Chapter eight of the book consists of the examination of toxic agents. In forty-six pages the author has tried to give succinct information on toxicological chemistry. This portion of the book might well have been omitted, the author merely referring us to other books for such information, instead of treating the subject so perfunctorily. He might have, on the other hand, tabulated all the available information as he has tried to do in the earlier portions of the book, thus enlarging as also making the book more useful and complete.

The book gives more than a hundred and twenty references to original sources of information. An author index and a subject index have also been appended, making it easy for reference.

These books, being published as they are during war time, are priced quite cheaply.

ENNE.

The Scientific Principles of Plant Protection. By Hubert Martin. (Edward Arnold & Co., London), 1940. Pp. vii + 385. Price 22*sh.* 6*d.*

This book was first published in 1928: the present edition appears only four years after the second edition and, while following its plan, includes a discussion of the many recent developments in ways and means of controlling pests and diseases of crop-plants. Its object is to present to the entomologist and the mycologist a detailed survey of the physico-chemical factors underlying modern control methods, and to provide the chemist and the physicist with a means of approach to the biological side, thereby promoting co-operation between workers in these various fields.

A large part of the book, roughly two-thirds, is devoted to fungicides and insecticides, fumigants, methods of treating soil and killing weeds, the toxic action and chemical constitution of substances employed in plant-protection and the like. The smaller part discusses the question of plant-resistance and the influence of external factors on the susceptibility of the plant to attack, the problems of biological control and the chemistry and tropisms involved in traps and baits; there is a final chapter on the treatment of the centres and vectors of infection. Emphasis has been given to the physico-chemical aspects of plant-protection because those who have to advise on its practical problems are primarily trained biologists, but, as the author himself recognises, this emphasis does not imply the greater importance of chemical over biological and cultural methods of control.

The data that Dr. Martin has extracted from his wide survey of the literature of crop-protection have been concentrated with a most economical use of words and arranged in short sections each of which is followed by a list of references. There is a good subject-index which is an essential adjunct to a work of this type; there are no illustrations.

For those engaged in extending the use of insecticides and fungicides in India and in working on indigenous sources of toxic materials, the revised edition of this book will be most welcome; it will prove to be as useful to the one who has access to a well-stocked library as to another who is almost entirely deprived of these facilities. Possibly some of the terser abstracts may not be easy reading, *e.g.*, Arsenicals "induce an inactivation of the oxidising enzymes, perhaps by an interference with the normal functioning of glutathione in the oxidation-reduction phenomena of the cell tissue" (p. 162), or "the bridging species serves to fractionate an initial mixture of biologic forms" (p. 331); but nevertheless they make far less demands on the time of the reader than do the orignal articles.

The new edition contains much new material and the old text has been drastically pruned and reset; it should be obtained by all who need to keep up to date in a field where methods are embarrassingly many and varied.

C. F. C. BEESON.

Organisers and Genes. By C. H. Waddington. (Cambridge University Press, London), 1940. Pp. x + 160. Price 12*sh*. 6*d*.

The author who is well known for his contributions in the field of genetics and of experimental embryology attempts in this book to bring about a synthesis between these two divergent fields of study. 'The discovery of genetic factors reveals only the first line of a chain of causal events whose other end, the adult character, is known, but whose intermediate links require elucidation. The genes cannot be regarded as immediately effective in causing the successive processes of differentiation, although they are undoubtedly the fundamental elements which ultimately control them.' On the other hand, Spemann's theory of organisers founded on experimental data and supported since by a large number of investigations in the field of experimental embryology, provides the 'causal network' underlying the processes of differentiation.

After setting the problem in the first chapter, the author deals in the next few chapters with relevant problems and questions raised by the results of experimental investigations on organisers. Chapters VI and VII deal with, for an ordinary biologist, abstruse investigations on genic actions and gene reactions. In the next chapters are discussed, first, the processes which lead to the establishment of chemical differences between the various organs within the organiser; then, are considered the chemical differences produced by induction; and finally, the problems of the development of morphological patterns are dealt with. In the last chapter (Chapter XII) the new concepts of 'fields' and 'levels of organisation' in developmental processes are discussed.

The book is highly stimulating and will prove of immense value to investigators in these fields. To the student, it summarises our knowledge, up-to-date, of organisers and of genes in relation to development.

S. G. M. R.

Grassland Investigations in Australia. (Imperial Bureau of Pastures and Forage Crops, Aberystwyth, Wales, Herbage publication series, *Bulletin* No. 29), 1940. Pp. 106. Price 5*sh*.

In reviewing *Bulletin* No. 26 on "Research on Grassland: Forage Crops and the Conservation of Vegetation in the United States" (this *Journal*, 1940, 9, 192), attention was drawn to the immensity of the problem of improvement of the world's grasslands. It was pointed out that one *Bulletin* (No. 14) was issued in 1934 dealing with the work on grasslands in Australia. The publication of another *Bulletin* on Australian work, within the short interval of six years, points to the great importance that is given to this problem in that country. It shows one more thing: that an agricultural country like Australia has not only taken advantage of the recent developments but has gone further at a rapid space to increase her livestock and dairy industries on which her prosperity depends. This is fully borne out by the increase in the imports of dairy products from Australia into India. It is a sad commentary on conditions in this country that under similar conditions and with a greater and faster increasing human and cattle population than that of Australia, no co-ordinated effort is yet made to encourage research on grasslands.

The great advance made in Australia in the improvement of its grasslands is all the more surprising when one bears in mind the fact that though it is larger by one-third than India, the net area of land available for pasture improvement is not more than half a million square miles or approximately one-sixth of the total area of Australia. The question that arises in one's mind is: How then has Australia attained its present position? Intensive research by about 15 institutes and commercial companies whose programmes are controlled by a Central Body—the Division of Plant Industry of the Council for Scientific and Industrial Research—has rendered possible this phenomenal progress.

Before undertaking pasture improvement, several surveys were carried out: (1) Soil survey by Prescott: this revealed that the podsol and red-brown earths were deficient in phosphate and nitrogen and emphasised the necessity for using phosphatic fertilizers and the cultivation of clover on these soils; (2) a survey of the density and type of

stock population of Australia; this served to mark out the regions requiring concentrated attention; (3) a survey of the types of grasslands in the northern semi-arid areas: this revealed the variations in grasses according to topographical, geographical and climatic conditions.

It may be mentioned here that one important feature of the work of the Division of Plant Industry relates to the irrigation of pastures. Nearly three quarter of a million acres of low carrying pastoral land have been brought under intensive production as a result of irrigation.

The importance of a survey of the grasslands of India as suggested by the reviewer in 1938 (this *Journal*, 1938, 6, 600) will be readily appreciated. It is hoped that such a survey would be taken up in the near future as it would point the way for the proper utilization of about 25 per cent. of the cultivable waste lands of India.

F. R. BHARUCHA.

THE INVERTEBRATES

The Invertebrates: Protozoa through Ctenophora. By Libbie Henrietta Hyman. (McGraw-Hill Publishing Co., Ltd., London). Pp. xii + 726. Price 36*sh*.

A TEACHER in Zoology for advanced classes often wishes with a sigh that somebody in the English-speaking world got busy to give him a book in English comparable with the German treatises, Kukenthal-Krumbach's *Handbuch der Zoologie* and Bronn's *Klassen und Ordnungen des Tierreichs*. The obvious reason for the absence of such a book in English appears to be that generally we fight shy of a bulky book. But it also appears impossible to avoid the use of large and voluminous tomes in higher zoological teaching. All over the world fresh light is being thrown on old problems, new problems have come to being and generally, new concepts and ideas are constantly taking the place of older ones so that Zoological teaching would cease to be the useful thing it is, if it did not keep abreast with the times. Two very different kinds of scientists bend their energies to the production of apparently two different kinds of results. First, there is the researcher who is interested in tackling new problems. And there is the other kind of worker, who is constantly co-ordinating the results of the researcher and making them available in an easily assimilable form to the student. Generally, seeing how arduous the latter task is, but how less intellectual, many are drawn away from it. Its importance is nonetheless to be admitted, for the original investigations of the brilliant researcher would otherwise be lost in the oblivion of the musty tomes of Zoological journals if they were not resurrected and reshaped to the needs of the student and placed within his reach.

It is staggering to think that it is nearly forty years since an exhaustive treatise on invertebrates appeared in English. It is sad to contemplate that during this long period Zoological teaching did not advance a step further, only because Zoological research was not correlated with Zoological teaching. In 1939 much of what was taught to the classes was based on what was found in Lankester's Treatise (which was never completed) and which was published 39 years ago. It was not because Zoological knowledge had not been furthered but only because this knowledge had not been brought within the reach of the Zoology teacher. This task, evidently a stupendous one, has just been undertaken by L. H. Hyman whose book under review forms the first part of the first volume of a series of three volumes planned for invertebrates.

We recently had an opportunity of reviewing another new book on invertebrates (Parker & Haswell's *Text Book of Zoology*, Vol. I, in *Current Science*, Sept. 1940) where the type method of treatment was employed and we felt that that method though advantageous to the beginner was full of defects where higher Zoological teaching was concerned. Dr. Hyman recognises them and adheres to the description of the phylum, emphasising the numerous morphological variations met with in it, a method which the reviewer feels is the most suitable for the needs of the advanced student. Likewise, elaborate descriptions of parasitic forms have been omitted. Parasites have recently come into their own,

and treatises dealing exclusively with them have appeared in large numbers. Elaborate schemes of classification, phylogeny and palæontology also have no place in a purely morphological treatise and so have been given but brief consideration.

The first two chapters deal with the general principles of Biology, like the structure of the cell, the protoplasm, and the principles of Zoological classification. The third chapter deals with the Protozoa. It is impossible to give an adequate account of this group of animals within the space of less than 200 pages allotted to it. But the author has endeavoured to incorporate much of the more recent knowledge on the structure and bionomics of Protozoa. It is refreshing to see, in the short space available, the correction of many erroneous beliefs regarding the physiology of the group. An instance in point is the contractile vacuole, which, in the older text-books was described as performing an excretory function, and which later work has proved to be more or less incorrect, substituting a mere osmoregulatory function to this organelle. The neuromotor system of the Protozoa is another aspect of recent research and Dr. Hyman has condensed much of our knowledge, and with the help of beautiful illustrations, has given a fair summary of the structure of the neuromotor organs.

The Mesozoa are considered next, evidently because, though diplobastic like sponges and Cœlenterates, the second layer in these animals does no digestive function and so is probably not homologous with the similar layer in sponges and Cœlenterata. But the apparent simplicity of organisation might in reality be a result of degeneration, for these animals are all endoparasites. However, the anomalous position of this group has been so unsatisfactory that the author thinks it a better plan to place this group, at least provisionally, between the Protozoa and the Metazoa. An illuminating chapter on the general characters of the Metazoa follows, which includes a brilliant analysis of Haeckel's Recapitulation Theory and the bearing of the recent work of Sewertzoff on the problem.

The Porifera occupy a peculiar position in the animal series. Their organisation clearly indicates a very low metazoan place for them. Their highly developed and varied skeleton, their peculiar choanocytes and their unique physiology lead us to conclude, with the author, that the Phylum Porifera "is obviously a blind branch of the animal kingdom that has no direct relationship to the Eumetazoa".

The rest of the book, nearly half of it, is devoted to a consideration of the Cœlenterata. The author, though not opposed to the usage of the term Cœlenterata, does not employ it as frequently and as freely as the previous writers on invertebrates have done, and prefers to follow Hatschek by dividing it into Cnidaria and Ctenophora, and elevating the latter to the rank of a distinct phylum. While this is admissible on some grounds, such as the absence of the nematocysts in Ctenophora, there is no doubt whatsoever that the Ctenophora are most nearly related to the Cnidaria, as the author herself admits. The resemblances are far too many and too striking to be overlooked, and many of the differences are either too insignificant or are due to an advanced organisation and the different habits of Ctenophora.

Throughout the book the treatment of the subject indicates a happy blend of comprehensiveness and clarity and the beautiful illustrations,—all of them line drawings—make the book doubly attractive and useful. If the others in the series follow the same plan of treatment and format as this one, we might safely prophesy that it will be the most useful text-book on invertebrates to the student. B. R. S.

THE CENTRAL REVENUES CONTROL LABORATORY NEW DELHI

BY

H. B. DUNNICLIFF, C.I.E.

(Chief Chemist, Central Revenues, Government of India)

THE first chemical work done in connection with the assessment of sea-borne imports to duty was in the determination of the spirit strengths of potable liquors in the Gauging Departments of Custom Houses. In the first instance, all customs duties were assessed on a flat *ad valorem* basis and the administration of this tax did not involve the chemical examination of goods other than spirituous liquors.

Gradually, however, variations arose in the rates of duty on different classes of articles and, in many cases, within those classes on the types and grades of manufactures as indicated by percentage composition, instances of which in the current schedule are mixed textiles, paper, paints, dyes, petroleum products, condensed milks, chemicals, cements, certain articles containing precious metals and many others.

World progress in industrial chemistry resulted in the manufacture of many important commodities frequently marketed under fanciful and often misleading trade names. The range of goods of this kind covers an immense field of utility and is consequently on the increase.

The examination of such synthetic compounds or mixtures in order to determine their allocation to the correct item in the Indian Customs Tariff for assessment to duty calls for much analytical skill and resource. A study of the tariff will show that more than half the classes of import mentioned are susceptible to chemical examination in connection with their assessment, and the amount of revenue involved is very large. The increase in the number of headings and sub-headings in the Tariff was gradual in its progress but cumulatively very considerable and ultimately introduced the necessity for the creation of some regular and reliable agency for chemical testing of many articles at the principal sea-ports.

In 1912, a combined Customs and Excise Laboratory was set up in the Calcutta Custom House but analytical work at the other major ports of Bombay, Karachi, Madras and Rangoon was carried out by the Chemical Examiner to the Local Government on payment. After some years, however, it was found that this arrangement was not working very satisfactorily, mainly because of the increasing number of samples sent for test and the unavoidable delays involved thereby and on account of the distance of the Local Governments' Laboratories from the Custom Houses.

As a result of a careful review of the whole position, it was decided in 1926 that the work of examining samples could be more expeditiously carried out and at less expense to the Central Government, if suitable laboratories were equipped and staffed in the Custom Houses themselves. In this way delays annoying to importers would be avoided and there would be the additional advantage that the laboratory, like other departments of the Custom House, would be under the direct administrative control of the Collector of Customs.

Laboratories provided with certain essential apparatus and chemicals from Calcutta were first opened at Rangoon and Karachi but the equipment and staff were inadequate and it was decided that a specialist officer must be appointed to put the organisation of the existing laboratories on a suitable footing and open up similar analytical departments in the Custom Houses at Bombay and Madras.

In 1928, the Government of India selected the Chemical Examiner for Customs and Excise at Calcutta, Mr. R. L. Jenks, to

undertake this development and to stardardise the methods of analysis to be adopted at all ports. Unfortunately, in the July of that year, Mr. Jenks fell seriously ill and had to proceed at once to England.

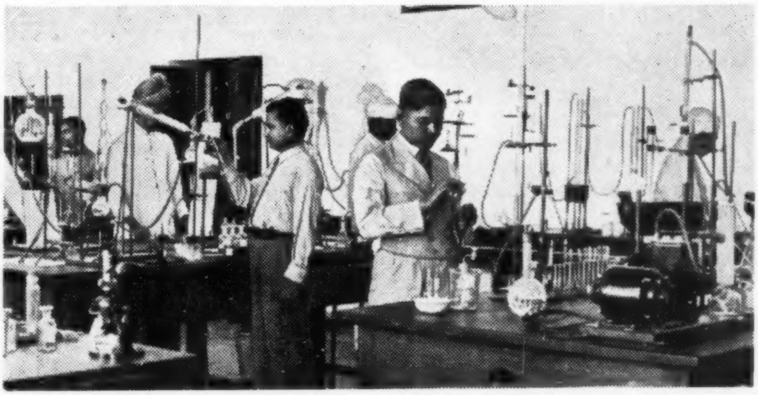
The following October, the author was appointed Special Chemical Adviser (Customs) to the Central Board of Revenue and the four new laboratories were in operation by April 1st, 1929, although the equipment and staff was not complete in all cases.

Proposal for a Control Laboratory

An integral factor of the scheme for the administration of these laboratories was the inauguration of a Central Control Laboratory, the functions of which would be to deal with technical matters such as the standardisation of analytical methods, the issue of instructions for the testing of goods presenting special difficulties, the investigation of chemical problems arising at the port laboratories and the re-examination of samples relevant to cases in which the importer had appealed against the assessment of the Collector at the port. It was also necessary to have an independent laboratory at which a selection of routine samples from each laboratory could be examined periodically by competent chemists to make sure that the standards and methods used at port laboratories were efficient and identical. There was also a demand for a technical advisory officer to whom questions of a scientific nature from the Central Board of Revenue and, incidentally, miscellaneous chemical problems from other Government Departments could be addressed.

This scheme, though accepted in principle, was to be tried out experimentally before embarking on the building and equipment of a Control Laboratory.

Arrangements were, therefore, made with the Punjab Government for the Control Laboratory to be accommodated temporarily in the Chemistry Department of the Government College, Lahore. A small staff was appointed under the administrative and technical control of the author who undertook the part-time appointment of Special Chemical Adviser to the Central Board of Revenue in addition to his post as Professor of Chemistry in the College.



The Main Laboratory

The scope of the scientific responsibilities of the Special Chemical Adviser increased progressively, first opium, then salt advisory and investigation work being added to his duties for Custom Houses. Further demands were made on the services of the Control Laboratory from time to time and it eventually became obvious that there was too much work for a part-time Chemical Adviser and the small staff and restricted facilities at Lahore. As a result, it was decided that certain of the functions which the scheme proposed should be served at the central laboratory should be undertaken elsewhere until the Control Laboratory was placed on an individual footing.

Accordingly, to the Calcutta Custom House were assigned the purification of contraband cocaine by a chemist trained at Lahore and

the newly devised co-ordination scheme for testing potable spirits and spirituous and medicinal preparations, while the standardisation of hydrometers and certain excise work already being done there for certain Indian States, Local Governments and Centrally Administered Areas and intended ultimately to be moved to the Centre, remained undisturbed. To Bombay was given the co-ordination schemes for restricting the testing of dyes, mineral greases, lubricating oils and certain other petroleum products.

After this modified scheme had operated for about six years, during which the Customs and Opium Chemical Service had come into being, the Government of India decided on the appointment of a full-time Chemical Adviser and the construction of a separate building for the Central Revenues Control Laboratory. The question arose as to where this central laboratory could be most suitably located.

From the first, the general view was that it was undesirable that the Control Laboratory should be accommodated in any of the Custom Houses as it was considered inexpedient that control work should be carried on in immediate association with the routine analytical work at any one of the Board's laboratories. From an administrative standpoint also it was agreed that a place nearer the Government of India headquarters would be most suitable.

A suggestion that, by arrangement with the University of the Punjab, the Control Laboratory should be accommodated in the University Laboratories was rejected after considering all the implications of the proposal.

Similarly, in connection with the construction of a new Custom House at Calcutta, it was originally proposed to house the Control Laboratory in that building but this scheme was eventually dropped in favour of a more central site at Delhi.

Delhi Chosen for the Control Laboratory

The final decision followed upon a national calamity, the Bihar earthquake of 1934.

When, as a result of the damage caused to the Pusa Laboratories by that disaster, it was decided to transfer the Imperial Agricultural Research Institute to the present site at New Delhi, it was felt that, without inconvenience to the Institute, the Control Laboratory of the Central Board of Revenue could be built within its precincts. It was considered that it would be mutually beneficial to have such scientific departments near each other and that, apart from technical advantages, it would avoid duplication in the cost of some essential expensive services such as gas manufacture, high pressure water supply, electricity mains and sewerage. Furthermore, certain departments of the two institutions could be mutually helpful, as, for example, the library, the constant temperature rooms, the store room for dangerous petroleum and other inflammable solvents, safe deposit facilities and the use of certain expensive apparatus.

The proposal was accepted in principle in 1935 and, at a cost of about Rs. 5,000, the capacity of the gas-plant of the Institute was increased to meet the future requirements of the Control Laboratory but, though the site for the Central Revenues Laboratory was reserved, financial considerations prevented further immediate action.

The Laboratory, its Staff and Equipment

In 1938, however, the Government of India decided to put into execution the plan for the construction and equipment of the laboratory.

The sanctioned cost of the building and equipment was as follows:—

Construction of the Laboratory including electrical equipment, sanitation, etc.	Rs. 47,400
Construction of Chemical Examiner's bungalow staff, garage and cycle shed, godown and inferior servants' quarters	„ 24,600
Portable furniture and laboratory benches, etc., involving the incorporation of gas and water supply; gas supply, water supply, workshop tools, picture rails, etc.	„ 25,240
Apparatus and Chemicals ..	„ 23,000
Books	„ 3,000
Gold-plating plant	„ 970
	Rs. 1,24,210
Addition to gas plant ..	„ 5,000
	Rs. 1,29,210

The accommodation comprises a large general laboratory (41′ 0″ × 30′), a smaller laboratory (33′ × 19′) mainly devoted to excise work and standardisation of instruments, a combined office and laboratory (17′ 9″ × 19′) for the Chief Chemist, a dark room (16′ 6″ × 8′), a combined balance and precision instrument room (20′ 6″ × 12′ 3″), a furnace room (19′ × 11′), a rest room (20′ 6″ × 16′) which being suitably fitted can, when necessary, be also used for testing explosives as it is correctly lighted

and free from any risk of fumes, a combined library and museum (29′ 7½″ × 20′ 6″), an office (25′ 9″ × 20′ 6″) and a workshop (15′ 6″ × 20′ 6″) together with the necessary lavatories and store-rooms for apparatus, chemicals, records and remnant samples.

The workshop is equipped with an electric lathe, a drilling machine, a forge, a carpenter's bench, a gold-plating plant and buffing and polishing machines.

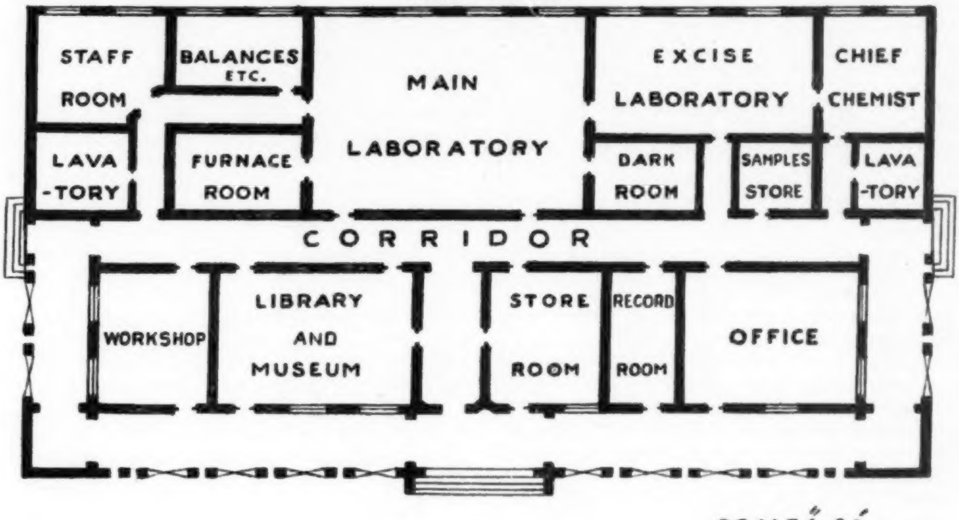
The walls have been provided with chases for air-conditioning and it is hoped that, as the laboratory will operate throughout the year, this desirable amenity will be supplied before next hot weather.

The general arrangement of the rooms is shown in the line plan.

The building, furnishing and installation of essential services were completed by the Central Public Works Department in October, 1939 and the laboratory was taken into service from November 9th of the same year, a start in the experimental work being made with such apparatus as was brought from Lahore augmented by purchases from Calcutta and elsewhere as, owing to the war, the greater part of the apparatus and chemicals from Europe and America had not been received.

The apparatus for the purification of contraband cocaine and the excise work done by the Calcutta laboratory was taken to Delhi early in December together with the relevant records.

CENTRAL REVENUES CONTROL LABORATORY
NEW DELHI.



SCALE 1″=24′

The air-conditioning plant will be placed at the west end of the building while an impression of the exterior of the building, the back of which faces due north, and the main laboratory can be obtained from the photographs published by the courtesy of *The Statesman.*

Owing to the limited space available, a residence was not provided for the Chief Chemist nor the majority of his scientific and ministerial staff. A suitable bungalow has, however, been built near the laboratory for the Chemical Examiner and a number of quarters for inferior staff.

The Control Laboratory Staff

The entire staff was transferred from Lahore and the Assistant Chemical Examiner and a Chemical Assistant from Calcutta, the rest of the sanctioned establishment being appointed by direct recruitment.

The personnel is as follows:—

The Chief Chemist, Central Revenues, who is also Director of the Control Laboratory.

The Chemical Examiner (Grade I), Central Revenues Control Laboratory.

The Assistant Chemical Examiner, Central Revenues Control Laboratory.

One Chemical Assistant (*Grade I*) (Rs. 300–20–400) and, including one chemist for the Central Excises and Salt Department.

Three Chemical Assistants (Rs. 150-10-250-E.B.-10-300).

In addition, the laboratory is available for use by the technical staff of the Central Excises and Salt Department as occasion requires.

The three officers first named are members of the recently constituted Central Revenues Chemical Service (see Note*), a Central Service, Class I.

The Chief Chemist is an *ex-officio* member of the Technical Advisory Board constituted under the Drugs Act of 1940 and the present incumbent of the post is a member of the Drugs Supply Advisory Committee and also Chairman of the Salts Committee of the Department of Scientific and Industrial Research.

Altogether, thirty chemists are employed in the laboratories maintained by the Central Board of Revenue at Bombay, Calcutta, New Delhi, Ghazipur, Karachi and Madras.

At the Control Laboratory, there is an instrument maker and a head laboratory attender and store-keeper while each chemist is allowed one laboratory attender to assist him in chemical operations.

The ministerial staff consists of an office superintendent, a stenographer, one upper division clerk and four lower division clerks including one for Central Excises and Salt. Adequate inferior staff has also been provided.

THE DUTIES OF THE CONTROL LABORATORY

As has been shown above, the chemical work from which this expanded scheme and the construction of the Control Laboratory arose dealt primarily with the examination of imported goods in order to ensure the correct assessment of the merchandise to customs duty. This is still the main function of the laboratories at the Custom Houses though they do other chemical work, such as the testing of explosives and petroleum products for Labour Department and foodstuffs for the Port Health Department, classification of oils for duty and railway freights and the examination of a variety of export samples under recent war legislation. Although many changes have occurred in the Indian Customs Tariff since the article was written, a very fair idea of the duties of the Custom House Laboratories can be gathered from the article "Chemistry in the Customs Department", published in *Current Science* of July 1935, pp. 42–46.

The duties contemplated for the Central Revenues Control Laboratory are also outlined in the earlier paragraphs of that article but, with the passage of time, the range of the analytical and advisory work expected of the department has expanded very materially. Thus, in addition to (*i*) the centralisation of the issue of standard lists of potable spirits and spirituous and medicinal preparations and of imported dyes, the object of which is to restrict the number of samples of these commodities sent for test, (*ii*) some general excise work, including chemical

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* The Central Revenues Chemical Service, a Central Service, Class I, is the youngest of the All-India Services. It was created by the Governor General-in-Council in 1937 under the designation "The Customs and Opium Chemical Service, Class I". When, subsequently, analytical and scientific advisory work for the Collectors of Central Excises and Salt were included in the duties assigned to the Service, it was re-named "The Central Revenues Chemical Service" in 1938 and the designation "Special Chemical Adviser", Central Board of Revenue" was changed to "Chief Chemist, Central Revenues".

The following ten posts are at present borne on the cadre of the Service. The grades of pay and headquarters of each officer are also shown.

Chief Chemist Central, Revenues (New Delhi).

Rs. 1,500–50–1,800 *plus* £ 30 sterling overseas pay if admissible.

Chemical Examiners, Grade I (4):

Rs. 600–40–1,000 for officers in the service before 1931 ;

Rs. 450–475 (on probation) 500–30–740–E.B.–35–950 for officers entering the service after 1931.

Chemical Examiner, Central Revenues Control Laboratory, New Delhi.

Chemical Examiner, Central Excises and Salt, Delhi.

Chemical Examiner, Custom House, Bombay.

Chemical Examiner, Custom House, Calcutta.

Chemical Examiners, Grade II (4):

Rs. 250–275 (on probation)–300–20–520–E.B.–550–30–700.

Chemical Examiner, Central Excises and Salt, North Eastern India, Calcutta.

Chemical Examiner, Custom House, Karachi.

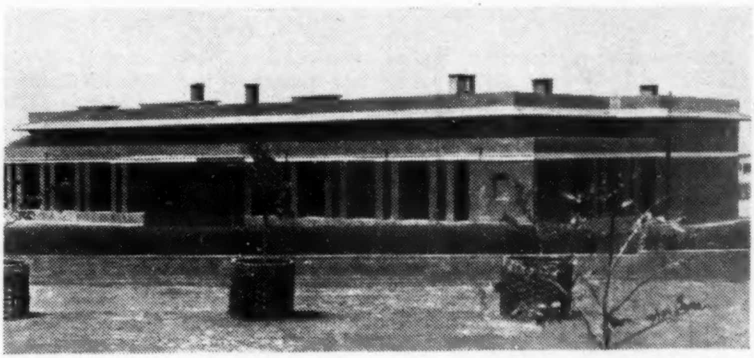
Chemical Examiner, Custom House, Madras.

Chemical Examiner, Opium Factory, Ghazipur.

Assistant Chemical Examiner, Central Revenues Control Laboratory, New Delhi :

Rs. 300–20–500.

examinations in certain classes of court cases and advice on problems connected with indigenous alcoholic preparations, etc., for a number of Indian States, Provincial Governments and Centrally Administered Areas, (*iii*) the purification of contraband cocaine for sale to Indian Medical Store Depots, (*iv*) appeal cases from Custom Houses and the Central Board of Revenue and (*v*) control analyses for the ports, the Central Revenues Control Laboratory serves a number of other functions of which the following will give some idea.



Central Revenues Control Laboratory, New Delhi

Hydrometers are standardised for the port laboratories and a gold-plating plant has been installed in the workshop for reconditioning brass instruments and balance-weights not otherwise damaged.

A number of laboratory investigations have been carried out in connection with the factory processes and the storage of opium at Ghazipur, such as the determination of oil in Malwa opium, the deterioration of opium on storage, the investigation of opium alkaloids and their derivatives used in medicine, *e.g.*, the manufacture of codeine, dionin, heroin and apomorphine, the possibility of the extraction of papaverine from marc of opium on a commercial basis and an attempt to separate opium into analysable fractions by the chromatographic method.

From time to time, technical notes are issued to port laboratories on the uniformity and standardisation of analytical methods on such diverse subjects as the determination of denaturants in imported spirits, the testing of kerosenes as regards their suitability as illuminants, the quantitative examination of paints, dyes, mixed fabrics, gold and silver plated articles, paper, extreme pressure lubricants, explosives, asphalts and refractories. A field of endless variety is the examination of imported preparations with fancy names in order to determine their description in terms of the Tariff, and sometimes to detect infringements of the Merchandise Marks Act.

Problems concerning various products in the sugar and nitre industries, the utilisation of bitterns salt from Sambhar in various manufactures, the examination of the East Lake salt deposits at Sambhar particularly with respect to the formation and amount of crystal salt available, the specification for marketable Khewra gypsum, the analyses of country-made soaps in connection with duty-free salt concessions, the denaturation of salt for various industrial purposes and the determination of these denaturants after admixture are among the types of scientific work conducted for the Collector of Central Excises and Salt, North Western India, in the Central Revenues Control Laboratory in New Delhi.

While research work, as such, is not a major function of the Control Laboratory, original papers have been published from time to time on chemical problems successfully investigated. Chemists at the Board's other laboratories also make occasional contributions to scientific journals though there is little opportunity for such work at the ports.

Occasionally, an analyst is trained for a

Provincial Government or for one of the Board's Laboratories.

A number of enquiries are received from various official sources, asking for technical advice, often requiring experimentation in the laboratory or in the design or equipment of laboratories and it has been possible, with the approval of the Board, to accept a limited amount of such consultative work.

Recently, in conformity with the decision taken at the Excise Commissioners' Conference, 1937, the Provinces requested the Central Board of Revenue to prepare a schedule of potable alcoholic medicinal preparations which might be used for other than medicinal purposes with a view to imposing a Provincial Excise Duty on such preparations higher than that levied on other spirituous medicines. The lists were prepared by the Chief Chemist after consulting a number of authorities and have been generally accepted by Provincial Governments and the Indian States.

There is also a considerable volume of work in connection with controversial cases, the revision of regulations and schedules of drugs, etc., and advice to the Central Board of Revenue on technical problems connected with Customs assessment, Central Excises problems and the Opium Factory at Ghazipur.

From the foregoing short account of its work, it will be seen that the functions of the Control Laboratory are very comprehensive. In addition to being Director of the Laboratory, the Chief Chemist visits the Custom Houses and the Opium Factory to inspect the laboratories and advise on their equipment and scientific work. He also visits the salt sources and sugar, leather and other factories, etc., in connection with the departments of Central Excises and Salt.

The Central Revenues Control Laboratory was opened by the Hon'ble Sir Jeremy Raisman, C.S.I., C.I.E., I.C.S., Finance Member to the Government of India, on April 5th, 1940, in the presence of a number of distinguished visitors.

SCIENCE AND INDIAN INDUSTRY

INDUSTRIAL researches, covering a wide range of technical and scientific subjects, are described in the Annual Report of the Industrial Research Bureau for the year 1939–40.

The research work of the Bureau, carried out by the Research Branch at the Government Test House, Calcutta, comprised work on the improvement of paints, the manufacture of efficient dry-cells, the utilisation of vegetable oils as lubricants or fuels in internal combustion engines, investigations to aid the glass industry, and many other items of practical industrial value.

A wide range of industrial information was collected and supplied to private concerns, individuals, and Government departments. The Bureau also published a series of Bulletins on various subjects such as Indian refractory clays, titanium oxide recovery, the manufacture of liquid gold and of china glass for use in the ceramic and glass industries, and the utilisation of Indian vegetable oils as lubricants or fuels in engines. Arrangements were made for the publication of bulletins on the leather, handloom, and silk industries and on other industrial subjects.

Other activities of the Bureau were connected with the development of improved glass-melting furnaces and pots, the production in India of the materials necessary for the preparation of bakelite type and shellac moulding powders, artificial silk manufacturing possibilities, and numerous industrial enquiries.

The staff and consequently the activities of the Bureau suffered considerable curtailment at the outbreak of war, but the Bureau, including the Research Branch, were subsequently merged into the recently formed organisation of the Director of Scientific and Industrial Research, by which this kind of work is being continued on a larger scale.

RADIO IN UPPER AIR INVESTIGATION

BY
S. V. CHANDRASHEKHAR AIYA
(*School of Radio-Physics and Electronics, S. P. College, Poona*)

1. Introduction

THE values of temperature and humidity and the velocity and direction of wind vary with altitude in the atmosphere and are also subject to seasonal and diurnal variations. For purposes of weather forecasting, data regarding these would be of enormous value if they can be collected at frequent intervals from a network of observatories. A knowledge of the height and thickness of cloud is also of importance to the meteorologist. A study of the variation in the intensity of ultra-violet solar radiation with altitude has proved to be of great help for elucidating the composition of certain layers of the atmosphere. Accurate information on the variation of cosmic ray intensity with altitude has been useful in elucidating the nature of the radiation. These several problems of the upper air have already been attacked and a considerable body of data collected.

There are at present three principal methods for studying conditions in the upper air:—

(*a*) A direct ascent is made in an aeroplane or a manned balloon and the required quantities are measured at different altitudes. This method, while useful, is costly. Besides, it is difficult to ascend to great heights without elaborate organisation.

(*b*) The second method is to send up an automatic recording instrument like the Dines' meteorograph in an unmanned balloon. After the balloon has burst, the instrument descends by parachute and, if it lands in a populated area, can be picked up and the records worked out. This method is comparatively inexpensive and easy, but has its disadvantages. In countries like ours, about fifty per cent. of the instruments sent up are never recovered. There are regions like Baluchistan, the Himalayas and the seas surrounding the country where the recovery would be so difficult as to be practically impossible. Some instruments are returned in a damaged condition. Often there is a considerable delay in getting back the instrument. These are serious drawbacks of the method.

(*c*) The third method is the radio method. A small radio transmitter is sent up with a balloon. The varying readings of the different instruments which accompany the transmitter are signalled in a suitable manner by the transmitter and can be received by a radio receiver at the ground station. This method has considerable advantages over the other two and need not be very expensive. In due course, it may become practically as inexpensive as the second method which is at present the cheapest. "Radio-Sonde" as this instrument is popularly called is constructed in different ways and is being used with varying success in several countries (see references I to IX). In some countries like the United States of America, this method already forms part of a regular service for collecting information for weather forecasting purposes.

In this paper, it is proposed to give a critical review of the main principles and practice of the method with special reference to starting the work in our country.

2. Transmitter Design

Upper air data at levels up to 20 kilometres are generally required. The balloon which carries the transmitter ascends at the rate of about 200 metres per minute. It, therefore, requires about a hundred minutes to reach the maximum height. During this time, the balloon is carried by the wind and travels a horizontal distance which generally lies within 200 kilometres. In most cases, the distance travelled is much less. The transmitter has, therefore, to be designed in such a way that it can radiate signals of sufficient intensity for satisfactory reception from a distance of 200 kilometres. At this distance, the transmitter radiates energy at an angle of 3° to 4° to the horizontal. Hence the radiation practically travels along the ground. Work has been done on the calculation of intensity at different distances in such cases.[28] The theoretical calculations do not agree exactly with experiment. For purposes of a rough estimate, it will be adequate if calculations are carried out on the basis of the simple theory of the Hertzian dipole, as the signal received is mostly a direct one, *i.e.*, *via.* the optical path. For a *half-wave aerial*, this theory gives the following value for the field X, at a distance d (in metres), from the transmitter:

$$X = \frac{94 \cdot 2}{d} \cdot I_s \text{ volts/metre}$$

where I_s is the antenna current in amperes.

This calculation neglects diffraction, reflection from the ground and refraction through the atmosphere. Diffraction can be neglected as we are concerned with transmission along the optical path. Reflection can be neglected as most parts of our country are not flat but hilly. Refraction would cause a fading of the signal.

The field, X, must have a value exceeding the noise level. Atmospherics and man-made statics like motor-car ignition, etc., are responsible for this noise. It is, however, generally well-established that noise level is below a fraction of a micro-volt per metre on wave-lengths below 15 metres. But man-made static may be so serious that it may raise the noise level between 5 and 10 metres to about one micro-volt per metre. Below 5 metres, this noise is quite negligible. Therefore, we may tentatively conclude that a signal of one micro-volt per metre can be received. Actually receivers can be so sensitively designed that a signal of even ¼ micro-volt per metre can be received. But

the lower limit of signal strength is also determined by the noise level and hence the above conclusion.

Substituting for X the value, one micro-volt per metre and taking $d = 200$ kms., we get

$$I_s = 2 \cdot 12 \text{ milliamperes.}$$

This gives the average current required in the antenna. Therefore, the maximum current will be $\pi/2$ times this, *viz.*, 3·33 milliamperes. The antenna, therefore, requires an R.M.S. current of 3·33 mA and, being a half wave antenna, has a radiation resistance of 80 ohms. Therefore, the power radiated will be 266·4 mW. Assuming 40% efficiency for the transmitter, the d.c. input works out to be 666 mW. Hence it is clear that a d.c. input of 10 mA at 67 V would be quite adequate. We have neglected the pure ohmic loss of power in the aerial. This can generally be kept down by proper aerial design. The battery Voltage falls due to drain and particularly due to the lowering of temperature at high altitudes. Taking all these factors into account, it is clear that 10 mA at 90 V as a d.c. supply to the transmitter is more than adequate. Actually satisfactory signals have been received with a 45 V plate supply![14]

Having dealt with the power requirements, the choice of wave-length may be considered. Wave-lengths varying from 150 m. to 1·6 m. have actually been used. The following facts must be considered in the choice of a proper wave-length:

Diagram to illustrate the "Olland Principle" used in radio-meteorographs.

(1) Decrease of wave-length leads to a reduction of noise level.

(2) The lower the wave-length, the shorter the length of the aerial.

(3) Smaller wave-lengths are advantageous for direction-finding. On such wave-lengths, it is easier to design sharply directed arrays.

(4) For wave-lengths much above 10 metres, there is always a possibility of other communication systems causing interference. Very often the trouble may be due to a harmonic from a nearby broadcasting station.

(5) The transmitter designed for this work does not maintain its frequency absolutely constant. This may cause interference with other communication systems. Hence a band that is least crowded must be used.

(6) Below 5 metres, the ordinary valves cannot be used efficiently and special valves will have to be used. This would increase the cost of the equipment.

Taking all these facts into account, it is evident that a wave-length between 4 and 10 metres would be the best. This is the general tendency in recent years. The international radio-sonde band is 10·7 to 10·9 metres according to the new convention. But it is probable that permission to work on lower wave-lengths can be granted in countries where the ultra short wave band is not put to much use.

The transmitter, for such wave-lengths and power, consists of a one-valve oscillator. In some cases, two valves are used in push-pull (13, 18). A high degree of frequency stability cannot be expected with such a simple transmitter but it is found that the frequency variation is small and practically negligible. If, in future, work is restricted to the international band, some type of master control will have to be used. The general practice is to use ordinary receiving valves, midget types or general purpose valves. For wave-lengths below 4 metres, acorn tubes are used and they are costly. When an ordinary receiving valve is used, the base is generally removed to reduce weight. In America, mostly the type 30 valve is used for the oscillator. Such a valve should cost us Rs. 3 or less.

With such valves, conventional circuits are generally employed. On longer wave-lengths, a tuned plate circuit inductively coupled to the grid circuit is common. On shorter wave-lengths, Hartley, Colpitts and tuned-plate tuned-grid circuits are generally employed. As far as possible, the use of resistors is minimised to avoid loss of power. On wave-lengths like 5 m., no extra capacity is required for the tank circuits of the tuned-plate tuned-grid type. The self capacity of the coils and the valve inter-electrode capacities are found to be adequate. The former can be varied by pressing the coil which really consists of a few turns of wire, for tuning.

Even after standardisation, the wave-length of the wave radiated is bound to differ slightly from one transmitter to another due to small differences in valve constants, circuit design, etc., but this is small. When the temperature changes, it affects the electrical constants of the circuit and the battery voltage. Besides, the battery voltage may change with drain. As a result, there is a frequency drift of the oscillator. This has amounted in some cases to as much as 300 Kc./sec. on the 60 mc./sec. band. To allow for such possible changes, it is desirable to use a flatly tuned receiver. Accordingly a super-regenerative receiver is very frequently employed. If a superheterodyne receiver is employed, slight retuning may become necessary now and again.

The aerial used is generally a half-wave antenna. In most cases, it is voltage-fed and this is found to be most satisfactory. A current-fed antenna has also been used but the former is to be fed at the centre and, therefore, will extend on both sides of the radio-sonde.

3. Transmitter Power Supply

The power requirements of the transmitter vary with the type and number of valves used. Speaking generally, they are roughly as follows:

L.T.: 60 to 200 ma at about 3V.
H.T.: 5 to 15 ma at about 90V.

The power required is extremely small but, since the power supply unit has to be as light as possible, it creates special problems. In the majority of cases, the greater part of the weight of the radio-sonde is due to the power supply unit. If the supply unit has a capacity enough to last about three hours, it is quite adequate and still the problem is serious.

Small accumulators are used for both H.T. and L.T. supplies by some. It is difficult to construct such H.T. accumulators. Small plates have to be formed and acid-proof insulation provided between cells. In places where there is an arrangement for making rubber containers and paste plates for aeroplane accumulators, the problem is not serious. But, in our country, it is likely to present a serious problem. There are, besides, certain general disadvantages of accumulators. There is the danger of acid spilling and spoiling other parts of the radio-sonde. The accumulator cools on discharge and as it is to be sent up to regions where temperatures are as low as $-80°$ C., special arrangements will have to be made to provide heat to the accumulator. Hence, it is preferable to avoid the use of accumulators.

Dry batteries have been used by several workers. If they are insulated in a balsa wood box, they are found to give reliable service. In our country, deal wood boxes may be tried with advantage. If the transmitter is designed for continuous operation, the heat of the valve or valves and the battery is adequate to prevent freezing in the battery. For L.T. supply, ordinary flashlight batteries are found to combine lightness and the required capacity. For H.T. supply, special layer-built (like a voltaic pile) 45 V batteries are manufactured for the purpose. The 'Eveready' 45 V battery weighs about 2 oz. and has a capacity of a few milliampere hours. But such batteries cannot be imported because they have only a short life. It should be possible to make such batteries in our laboratories after some initial experiments. Perhaps, we may not get down to as low a weight but still, this appears to be the best approach to the problem.

Some workers use dry batteries for L.T. and a vibrator transformer to convert L.T. to H.T. pulses at audio frequency. By this method, it is difficult to secure reliable operation and difficulty has been experienced in starting and stopping the transmission. Hence this would be a serious difficulty if the transmitter is designed for intermittent operation.

4. Signalling

Instruments for indicating pressure, etc., are sent along with the transmitter and several methods have been devised to signal their readings. The fundamental principles underlying the methods will be discussed briefly.

(a) *Moltchanoff's signalling method.*—The plate circuit is completed only when the indicator of the meteorological instrument makes metallic contact at certain predetermined values of the parameter to be measured, and for each value a different type of signal is sent. Thus, for a pressure of 800 mb., a letter *i* may be sent for 700 mb., the letter *o* and so on. If two parameters are to be measured, each sends a different type of signal. The operator at the receiver has to receive these signals and later decipher them. The method was used in the early days by Moltchanoff and recently by the Dutch workers. It is complicated and sends signals only at certain predetermined values of pressure, temperature, etc. This is a disadvantage.

(b) *Carrier frequency variation.*—The best example of this is the Finnish radio-sonde. By a drive mechanism, four different condensers are brought in parallel across the coil in the plate circuit in turn. Two are fixed. The capacity of one is varied by the pressure indicator and varies with pressure and that of the other is varied by the temperature indicator. Hence, the transmitter radiates in quick succession, two fixed and two variable frequencies. The variable frequency change is a measure of pressure or temperature, as the case may be. The variable frequencies are measured as a difference with respect to the fixed frequencies. Therefore, if there is any frequency variation due to temperature change, etc., it will affect all the frequencies. Hence the accuracy of the readings will not be affected.

The only factor affecting the accuracy lies in the fact that the instrument has to be calibrated with the aerial in position. Generally, different readings are obtained with the transmitter inside and outside a building. It should, however, be possible by certain preliminary experiments to make an allowance for this. The method gives readings of different parameters in quick succession so that it will be practically equivalent to obtaining information on the several parameters simultaneously. This is an added advantage of the method.

Vaisala works on the 15 mc./sec. band and the frequency variation required for measurements of the required accuracy is about 1000 kc./sec. It is extremely doubtful whether permission can be obtained to work over such a wide band, and, that too, in an important communication band. If we were to use the ultra-high frequency band, the capacities would become too small and its adoption would present difficulties but it is worth making an attempt. On the band used at present by Vaisala, there is likely to be interference from broadcasting and other communication channels. This will not arise on the higher frequencies.

(c) *Olland principle.*—Many radio-sondes operate on this principle. It can be illustrated by taking an example. (Fig. 1.) Suppose pressure, temperature and humidity are to be

measured. A pointer, X, is rotated at constant speed by a clock, motor or other mechanism. Let O be a fixed point on the circle which its end describes. The pressure variations move another pointer A from an angle of, say, 10° on the circle to another position, say, 110°. Similarly a third pointer B attached to the humidity indicator moves from 120° to the 220° when the humidity changes from 0 to 100 per cent. and a fourth pointer C attached to the temperature indicator moves from, say, 230° to 350°. Suppose the transmitter plate circuit is completed whenever the pointer X touches O or the pointers A, B or C. The signals corresponding to contact with O will occur at regular intervals of time. The signal due to A corresponding to pressure, due to B corresponding to humidity and that due to C corresponding to temperature occur at time intervals after the O signal depending on the values of these parameters. The duration of the signals due to O, A, B and C may be made different so that they can be distinguished. This method, therefore, would measure pressure, etc., in terms of time intervals. By this method, we can obtain consecutive, but not simultaneous records of different parameters.

The most common drive employed is the clock drive and this limits the accuracy of measurements. With any escapement, there are a limited number of jumps of the clock hand per minute and the least count of the indicator will be determined by the range of the parameter equivalent to each jump. Escapement errors are most common. Cheap watches and clocks are affected by temperature. When the temperature is lowered as the balloon goes up, sometimes they move faster because of increased spring tension but at some other times, they move slower because of the thickening of oil. Experience has shown that the variation in speed is thus rather erratic. Most of them stop operating below −30° C. They must, therefore, be kept in an insulated enclosure. It is difficult to supply the clock with the exact amount of heat it is likely to have at different altitudes inside this enclosure at the time of calibration.

Recently,[21] a motor drive of constant speed has been tried and is reported to operate at very constant speed. But the problem of obtaining or making such motors is likely to present difficulties for us here. Other types of drive have been tried but the above two can be considered as representative.

(*d*) *Modulation.*—Audio frequencies can be generated by a valve oscillator and the frequency can be varied by varying the inductance of the tuned circuit. In Thomas's method,[1] the inductance is varied by an iron disc attached to the indicating instrument, which moves as the parameter to be measured changes, and varies the air gap in the inductance. Hence the frequency of the audo-oscillator is a measure of the parameter to be measured. This audio frequency modulates the R.F. of the oscillator. At the receiving end, the signal is demodulated and the frequency of the A.F. measured. The latter is a measure of the pressure, etc.

In the audio-oscillator used by Dunmore and others[22,23] the frequency is varied by varying the value of the grid leak. Pressure, etc., vary the value of the grid leak and hence the audio frequency. In other respects, the design and technique are similar to those of Thomas.

This method requires extra valves for generating A.F. oscillations and modulation and extra power for the purpose from the power supply unit. The radio-sonde of Thomas weighs 2,390 grm. This is a very high weight for a balloon transmitter. Diamond and co-workers' radio-sonde weighs 2 lbs. It is difficult to reduce the weight of this type of radio-sonde to as low a value as that of similar instruments based on other methods. But, it is quite likely that this method will give the highest degree of accuracy. An added advantage of the method lies in the fact that the transmitter continuously radiates. Hence continuous records of all parameters can be simultaneously obtained by suitable design and adjustment of audio-frequency variations to different bands for different quantities, *viz.*, say, 700 to 1000 c/s. for pressure, 1400 to 1700 3/s. for temperature and so on as was done by Thomas. Besides, the same radio-sonde can be used for direction finding purposes also.

5. Application to Meteorology

The most important application of this method is to meteorology. The meteorologist requires a knowledge of pressure, temperature, humidity and wind velocity and direction for weather forecasting. In clear weather, wind velocity and direction can be obtained by sighting the balloon with a theodolite. But this is not possible in cloudy weather when a knowledge of wind velocity and direction would be particularly valuable. If the balloon transmitter is *continuously radiating* at a fixed frequency, its direction can be determined by suitable direction-finding apparatus and hence the wind velocity and direction obtained.

The transmitter has to signal the values of pressure, temperature and humidity. Pressure decreases with height from about 1000 mb. at the ground level to 50 mb. at 20 kms. A knowledge of pressure to an accuracy of 2 mb. is desirable. Temperature varies from 40° C. to −80° C. and an accuracy of 1° C. is required in temperature measurements. Relative humidity has to be measured to an accuracy of 5 per cent. It is desirable that the values of all these three quantities are obtained simultaneously, *viz.*, pressure, temperature and humidity at the same altitude. This is possible when the modulation method is used. In other methods, we obtain pressure at one time, *i.e.*, at one altitude, temperature at a later moment, *i.e.*, at another altitude, and humidity at a third altitude. A graph will have to be plotted to obtain the values of the three quantities at the same altitudes by interpolation. To avoid any error that may be caused by this method, the signals for the three quantities must be obtained in quick succession.

The instruments used for measuring pressure, etc., must be light and accurate. For pressure measurements, the aneroid is invariably used

and is found to be satisfactory. For temperature measurements, many workers use a bimetallic spiral. It is contended that it is difficult to design the latter to combine sufficient rigidity, stability and small thermal capacity. A wire suspended in an invar frame is used to indicate temperature and is found to work excellently. Craig[24] has constructed an electrolytic resistor, the resistance of which varies rapidly with temperature. This is used for temperature measurements by Diamond and co-workers. The bimetallic spiral is the simplest and cheapest. The metal wire suspended in an invar frame is probably the most accurate. For humidity measurements, the hair hygrometer is used by many. It cannot respond to abrupt changes and its time-lag is great at low temperatures. Curtiss and co-workers[21] use gold-beaters' skin and its response is found to be good. Dunmore[25] has devised an electrical hygrometer the resistance of which is found to depend markedly on humidity. This is used by Diamond and co-workers.

A knowledge of cloud height and thickness is of importance to the meteorologist. Feige[27] has determined them as follows. A photo-electric cell operates a milliammeter which varies the capacity of a condenser and this changes the carrier frequency of the transmitter. As the balloon passes through the cloud upwards, the light intensity changes and this alters the carrier frequency. Hence cloud height and thickness can be determined. Diamond and co-workers[23] connect the photo-cell to the grid circuit of the audio oscillator. Its resistance changes with light intensity and this changes the modulation frequency of the carrier wave.

6. Other Applications

Ultra-violet solar intensities in the stratosphere have been determined by an application of the radio method by Stair and Coblentz.[26] Their apparatus consists of an audio-oscillator, the frequency of which is determined by grid resistance. This A.F. modulates a carrier. By a special pressure switching arrangement, fixed resistors appear in the grid circuit of the audio-oscillator at predetermined pressures. This gives an indication of altitudes. Between pressure switching, a motor drive brings different light filters in front of a photo-cell connected to the same grid circuit. The resistance variation of the latter which corresponds to light intensities varies the modulating frequency. The latter is, therefore, a measure of light intensity.

Cosmic ray intensities[29] can be determined at different altitudes. Electrical impulses from a counter may be made to operate a relay to key the transmitter. The frequency of keying is a measure of the intensity.

Electrical conductivity and potential gradient can also be determined. Electrical charge may be collected on a conducting plate and this may be made to vary the grid bias of an audio-oscillator. When this varies, the audo frequency generated will vary. If the latter modulates a carrier, the modulating frequency will be a measure of the electrical conductivity.

7. Acknowledgment

The author thanks the Director-General of Observatories for permission to use the library of the India Meteorological Department and to see some of the radio-sondes available in the Department. He also acknowledges with thanks the assistance he received from Dr. K. R. Ramanathan by way of advice, discussion and suggestion while this paper was being prepared.

8. Summary

A critical review of the construction and use of the Radio-Sonde with special reference to starting research work in India on the subject is given.

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THE MARKETING OF GRAPES IN INDIA

THE recent Report* published by the Agricultural Marketing Advisor to the Government of India brings together much useful information regarding the production and trade in these fruits in India and stresses the need and the scope for extending the cultivation in the country. While the consumption of fresh grapes in India is nearly six and a half lacs of maunds and that of dried grapes is two and a quarter maunds India produces only some three and three-quarter maunds of the fresh fruits and none at all of the dried grapes, so that she imports over a third of her requirements of fresh grapes and the whole of her dried grape requirements from abroad. The present area under grapes is put down as 4,200 acres and the scope for extension to supply her full requirements is estimated as an additional 12,500 acres. In spite of this great scope for extension the areas under the fruit has remained practically unchanged, indicating the desirability of both experimental work and propaganda. It is interesting to note that Baluchistan accounts for about 58 per cent. of the present area, with Bombay coming next with 23 per cent.; Mysore and Madras account for 1·2 and 6 per cent. respectively. A description is given of the large number of varieties grown in the country and the peculiarities of their methods of cultivation. There appear to be numerous problems connected with the various aspects of the cultivation which are all indicated briefly together with useful suggestions in the same regard. A very noteworthy fact is the very high yield of the fruit in this country. India in fact leads in this matter; Mysore and Bombay give the highest yield per acre in the world, *viz.*, 11,610 lbs. and 11,160 lbs. respectively, with California—the great grape country—coming second far behind with 7,678 lbs. per acre. The report draws attention to the profits from the cultivation which is put down as about Rs. 600 to Rs. 700 on the average with Rs. 2,000 as the top figure per acre. As a profitable crop ideally suitable for the small farmer and therefore as a valuable aid in the improvement of village life, the grape is commended for greater attention. As in the case of most agricultural products in India there is great need for improvements in marketing. The grade specifications introduced in Bombay and the N.W. Frontier Province are referred to and it is stated that such grading has been a distinct success as the higher returns due to grading amounted to as much as Re. 1–6–8 per maund. Among the many suggestions for improvement are those relating to transport facilities and the provision of cold storage accommodation in the distributing markets. That considerable experimental work is called for is evident from the references made to past failures such as the Indian Mildura Fruit Farm in the Punjab and the Dal Lake plantation in Srinagar, Kashmir, to which we may add the Mysore Fruit Syndicate and other pioneer ventures in Bangalore of about thirty years ago. The rapid extension referred to as having taken place in the Madura District, South India, demonstrates also that with a variety which is found suitable, propaganda has been eminently successful. We should refer readers to the report itself for a fund of useful information collected with painstaking accuracy.

A. K. Y.

* *Report on the Marketing of Grapes in India and Burma* (Manager of Publications, Delhi), 1940. Price Rs. 1-14-0 or 2*s*.

INDIA METEOROLOGICAL DEPARTMENT

IN the Report on the Administration of the Meteorological Department of the Government of India* that has been recently issued, we have a brief survey of the various activities of the Department, and a concise account of the interesting developments that have taken place during the year. Considerable attention appears to have been directed as during previous years, to the subject of improving the weather forecasting facilities for airmen. The forecasting office at New Delhi was re-established and began to issue from 1939 October 1, forecasts and weather reports for aviators flying in the extensive area served by that centre. Some new observatories and current weather stations have been started to provide additional information along the principal air routes; and on the outbreak of war, arrangements were made for certain special services to meet the requirements of the Indian Air Force.

At the Meteorological Office, Poona, a new wireless station was opened in April 1939, for broadcasting synoptic weather messages. Thus there are in India, four centres collecting observations in their regions and broadcasting them as regional synoptic messages, *viz.*, Poona, Calcutta, Delhi and Karachi; the Poona Office, in addition, issues collective synoptics based on these regional synoptic messages, from which weather information for the whole of India can be obtained. The two systems are illustrated in Plates I and II of the Report.

Considerable progress has been made with the arrangements for the transfer of the Upper Air Observatory at Agra to New Delhi. Besides other advantages the transfer is expected to facilitate the establishment of a closer *liaison* of the Department with aviation interests.

Sounding balloon ascents have been made at seven stations; about 500 balloons carrying meteorographs were released, out of which 229 have been retrieved. In order to obtain more precise information about the structure, process of information and movement of tropical storms, it has been proposed to have a large number of sounding balloon ascents ("swarm ascents") made in the field of such storms during their progress over a particular area. The Department also rendered assistance to Dr. R. A. Millikan and his colleagues who visited India for securing data in connection with their researches on cosmic rays. The observations were made at Agra, Gwalior, Peshawar and Bangalore where large balloons carrying recording instruments were released for the purpose.

The section of agricultural meteorology has continued its useful work, chiefly in investigations connected with the effect of weather and climate on crops—a subject of supreme importance to a country like India which is mainly agricultural. The researches carried out by this section include, among others, the measurement of the effect of wind-breaks and shelter belts by means of a hot wire anemometer and an investigation to evaluate the effect of topography on local climate by comparative observations at four selected stations a few miles apart from each other. Of particular interest is the work on "precision observations" at Poona and Karjat designed to reveal the effect of weather on crops. By the application of the sampling methods developed by Prof. R. A. Fisher, important results have been obtained which are useful in studying the behaviour of the rice crop during six different seasons. Considerable attention has also been given to certain statistical investigations in connection with agricultural problems. It is gratifying to note that the Government has decided to finance this section from the Central Revenues for a further period of three years.

An important feature in the development of the Colaba Observatory is the appointment of a special officer for seismological research. Various problems relating to earthquakes in India and its neighbourhood have been receiving attention and investigations have been made of the characteristics of certain important shocks such as the Satpura Range earthquake of March 14, 1938 and the great Pacific earthquake of November 10, 1938.

At the Kodaikanal Observatory, studies of solar phenomena have been continued and observations have been made as usual with the spectroheliograph, the spectrohelioscope and other instruments. Among the special researches may be mentioned the detailed study of the bright solar eruption of March 3, 1939 and of the unusual solar activitiy during August and September 1939.

Appendix B of the Report contains a list of departmental publications issued during the year as well as of the occasional papers contributed by the members of the staff, which is a good indication of the amount of valuable and interesting work carried on by the Department in the various directions of its activities.

T. P. B.

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* *Report on the Administration of the Meteorological Department of the Government of India in* 1939-40. (Manager of Publications, Delhi), 1940. Pp. 35. Price Rs. 1-2-0.

CENTENARIES

Lexell, Anders Johann (1740–1784)

ANDERS JOHANN LEXELL, a Finnish astronomer, was born at Abo in the southwestern coast of Finland, December 24, 1740. He became professor of mathematics in the University of Abo in 1768 and went over to a similar post in St. Petersburg in 1771.

Lexell was a prolific writer. His first contribution entitled *Researches sur la vrale orbite de la comte de l' an* 1769, *etc.*, appeared in 1770. The last which appeared posthumously in 1787 was entitled *Disq. de theoremete quodem singulari Lamberti, etc.*

Perhaps Lexell's name is best known in connection with the discovery of Uranus, which was the first planet to be discovered in historic times. On March 13, 1781 Sir William Herschel noticed a new heavenly body larger than fixed stars and suspected that it might be a comet. For a long time people could not compute a satisfactory orbit for the supposed comet, because it seemed to be near the perihelion and no comet had ever been observed with a perihelion distance from the Sun greater than four times the earth's distance. Lexell was the first to suspect that this was a new planet eighteen times as far from the sun as the earth is. In 1783 Laplace published its ecliptic elements and Lexell's suspicion was confirmed. The paper of Lexell on the subject appeared in 1783 under the title *Recherches sur la nouv. planete discouverte per Herschal.*

Lexell's name is also associated with the discovery of the deflection of comets. In 1770 he discovered a comet which had been deflected in 1767 by Jupiter out of an orbit in which it was invisible from the earth into an orbit with a period of 5½ years, enabling it to be seen. In 1779 it again approached Jupiter closer than some of his satellites and was sent off in another orbit, never to be again recognised. Lexell's paper on the subject appeared in 1778 under the title *Reflexions sur le temps periodique des cometes en general et principalement sur celui observce en* 1770.

Lexell died at St. Petersburg, November 30, 1784.

S. R. RANGANATHAN.

University Library,
Madras.

SCIENCE NOTES AND NEWS

Radio-frequency Spectra.—In the *Physical Review*, 1940, 57, 765, P. Kusch, S. Millman and I. I. Rabi describe a new method for studying the radio-frequency spectra of atoms. When the energy of an atom changes on account of a change in the orientation of the nuclear spin, the frequency of the quantum corresponding to this change of energy is of the order of a few thousand megacycles, and the idea underlying the experiments is to produce oscillatory currents of such a frequency and employ them so that a reorientation of the nuclear spin is brought about. The occurrence of such a reorientation is examined by the method of molecular beams. A beam of atoms is projected through two inhomogeneous magnetic fields so arranged that the deflection of the beam produced by the first is exactly compensated by the second when the orientation of the atomic magnets is not changed during their passage from one field to the other. Next, a suitable homogeneous magnetic field is produced in the space between the two inhomogeneous fields. A weak oscillating field is set up perpendicular to the homogeneous field and the frequency is adjusted so that the nuclear spin of the atom changes from one to another of its possible positions in the given homogeneous magnetic field. Thus the frequency inducing such a transition is equal to that of the quantum corresponding to the change from one hyperfine Zeeman level to another. When such a reorientation occurs, the deflection due to the first inhomogeneous field will not be compensated by the second inhomogeneous field and hence the intensity of the atomic beam at the collector falls. By observing the various frequencies of the oscillating field at which such minima of intensity occur, the various hyperfine Zeeman components corresponding to the homogeneous magnetic field can be determined. This is called the radio-frequency spectrum of the atom. Since the authors were able to measure the frequency of the oscillating field to an accuracy of one in twenty thousand, the accuracy in the measurement of hyperfine structure components has been improved a hundred-fold, so that we may expect many questions of nuclear structure to receive new light from these measurements. As an example of the results, we may quote the following from the paper of Millman and Kusch, *Phys. Rev.*, 1940, **58**, 438.

Nucleus	$\Delta\nu$ of ground state in cm.$^{-1}$
Na^{23}	0·059103
Rb^{85}	0·10127
Rb^{87}	0·22797
Cs^{133}	0·30661

T. S. S.

Is produce grown with chemical manures deleterious to health?—A rather startling answer, in the affirmative, to this very important question is furnished by Dr. G. B. Chapman of the Physical and Mental Welfare Society of New Zealand and an account of a three-year experiment in the feeding of school-boys on fruit and vegetables grown on soil manured exclusively with 'humus' as against chemical fertilisers, conducted in one of the school hostels in that country is reported in support of the conclusion (*Nature*, June 8, 1940). It is stated that prior to the experiment the subjects, comprising some sixty boys, teachers and staff, were being fed on a liberal dietary well above the customary standard for boarding schools but that they were nevertheless consistently suffering from colds, catarrh, septic tonsils, epidemics of influenza, dental caries and other preventible complaints. The food supply was being derived from the ordinary New Zealand produce which, the report says, was all being grown on soils manured only with chemical fertilisers. It is rather hard to believe that New Zealand soils receive no kind of organic matter at all which would furnish humus; what then becomes of the farm-yard manure, the excreta of the sheep and poultry, the crop residues on the land, and all the plant material not used as or useful for food is not made clear. On the assumption however that the local produce is all from soils only manured with artificials, it was decided to grow on the school land, fruits and vegetables manured only with 'humus' for consumption in the hostel and these, it is said, now supply the greater proportion of the requirements of some 77 persons. In the twelve months following the change-over a marked improvement in health resulted. Catarrh, which was general previously, declined as likewise did cold and influenza. In an epidemic of measles in 1938 which was general in New Zealand new boys suffered from acute attacks while boys who had been in the school for a year or more (and fed evidently on the humus-grown food) suffered only mild attacks with a much more rapid convalescence. Fewer accidents occur in the football season indicating stronger bone formation; dental condition has improved, constipation and bilious attacks are rare and the boys are 'increasingly active and virile'.

Though a good deal is now being heard on the effect of farm-yard manure, as opposed to chemical fertilisers, in improving the "quality" of produce, in making the seed more productive, with a higher content of factors indispensable for growth promotion, one is hardly prepared for a sharp and vital distinction of the kind described in the above experiment. If the results can be confirmed by other workers and in a much larger number of experiments, under conditions capable of accurate control, it goes without saying, that they will have far-reaching practical importance besides bringing about a radical change in the present ideas of manuring and plant improvement. A. K. Y.

Entomological Results from the Swedish Expedition (1934) to Burma and British India.—The results obtained by the expedition have been reported in three papers published in *Arkiv. fur. Zoology* (32, Nos. 2–3). The expedition made extensive collections of certain common as well as little known insects in British India and Burma.

The greater portion of the collections consists of aquatic coleopterous insects belonging to the families Gyrinidæ and Dryopidæ.

The Gyrinid beetles are small shiny insects commonly found briskly moving about on the surface of water in ponds and streams, paddling themselves by means of their modified posterior legs, and excreting a fœtid liquid round about them.

Of the three important genera of Gyrinidæ, namely, Gyrinus, Dineutas and Orectocheilus, the last-named genus has been well represented in the collections besides yielding ten new species of considerable interest. The work of the Swedish expedition has thus widened our knowledge about one of the most interesting families of aquatic beetles.

The Dryopid beetles are little-known small, pubescent and aquatic beetles. The expedition has thrown much light on this family. The two principal sub-families, Dryopinæ and Helminæ have been studied in detail and one new genus and two new species in the former, as well as another new genus and three new species in the latter have been erected. The new subgenus Indosolus and the four new species of Grouvellinus are of considerable interest to the students of the family Dryopidæ.

Technical Institute, Delhi.—The Government of India have decided to convert the existing Government High School and Commercial Institute at Delhi into a *Technical Institute*, in pursuance of one of the main recommendations of the Abbott-Wood Report.

The proposed Institute will contain, in addition to an experimental Technical High School, provision for courses or classes in technical, commercial and art subjects for students already in or preparing to enter employment.

The Technical High School will provide for an annual intake of 60 pupils. The minimum age at entry will be eleven and the normal length of the course six years. The school will thus contain about 360 pupils and no reduction in the total facilities for higher education in Delhi will be involved. It is hoped to start the new venture in the school year 1941–42.

For the first three years the Technical High School's curriculum will be of a general character and similar to that followed in a good middle school so that at the end of this stage it may be possible to make transfers from and to schools providing the ordinary High School course.

After this stage the curriculum will include a certain number of subjects of a practical character, *e.g.*, the properties of materials, the elements of engineering science, measured drawing and simple design.

This second stage will last three years, the practical subjects occupying a progressively larger place during the last two years. Importance will be attached from the beginning to a sound practical knowledge of English and it will be possible for the pupils in their last year to take a suitable school leaving examination without any risk of their course of study being unduly circumscribed by examination requirements.

Mr. William Walter Wood, F.R.I., B.A., M.I.Struc.E., at present Principal of the Mid-Essex Technical College of Arts, Chelmsford, has been appointed Principal of the Institute. He is expected to take up his duties early in the new year.

Production of Drugs in India.—Owing to the extended production of drugs in India as many as 92 drugs have been taken off the import list.

The manufacture of disinfectants has been taken up by the Medical Stores Supplies Committee under the chairmanship of Lieut.-Gen. G. G. Jolly, I.M.S., Director-General, Indian Medical Service. The manufacture in India of Acriflavine is under investigation. Samples have already been produced in an Indian laboratory.

Tablets of vitamin C are now being produced from the Indian gooseberry, *amla*, which is available in large quantities in the Nilgiris. Amla berries are collected under the supervision of the Director, Nutrition Laboratories, Coonoor, dried and made into tablets of suitable size. The Committee is now contemplating the production of a more concentrated form of vitamin C.

Manufacture of China Glass.—The manufacture of China glass, a decorating material used chiefly by the glass bangle industry, is described in detail in a recent bulletin of the Indian Industrial Research Bureau (*Bull. No.* 17; Manager of Publications, Delhi, 1940. Price As. 5 or 6*d*.). The process was perfected about two years ago by the Research Branch of the Industrial Research Bureau at the Government Test House, Alipore, and it was subsequently demonstrated that large-scale manufacture should present no difficulties. The details of the process were supplied to various glass manufacturers, through the Directors of Industries of certain Provinces and States, and it has been reported that China glass is now being produced in India and is being marketed by certain glass manufacturers at a price somewhat lower than that of the imported material. The publication of this bulletin, it is hoped, will further encourage the production of China glass in the country.

China glass is a dense opaque white glass of low melting point. Low melting characteristics are essential, as otherwise the glass articles on which it is applied may be deformed during the process of application.

For decorative application, the solid glass is powdered fine—say to the consistency of ordinary flour—and a paste is made of it with water, and this paste is used to make the requisite artistic designs on the glass surfaces to be decorated. The decorated article is then fired in a furnace, which melts the decoratives and fixes them to the surface.

The material, when prepared as described on a factory scale, proved highly satisfactory and was comparable with the best quality of imported China glass.

A New Jute Substitute.—Among the new fibres and threads produced mainly as substitutes for jute, ramie, hemp and similar natural fibres, the "Hofa" thread has drawn some attention of the trade. This thread consists of wood fibre stock and viscose, the latter serving as a binder. In contrast to the practice in wood pulp production, the wood fibre stock is entirely freed from "fibre slime" and fine fibre fragments by thorough washing, so that a loose homogeneous fibre structure similar to that of raw cotton results. By suitable spinning and other treatment, a thread resembling horse hair is produced.

Atmospheric Pollution.—Despite the increasing industrial activity in the years preceding the outbreak of the war, the state of the atmosphere in the British Isles has shown a steady improvement since 1936. This is shown in the Report on the investigation of Atmospheric Pollution for the year 1938–39.

The local authorities making the measurements of atmospheric pollution on which these reports are based have decided to carry on with the investigation, if possible, since a knowledge of the state of the atmosphere is of importance even in war-time. Although more urgent tests have delayed its issue, the report on the year's observations has now been issued by the Department of Scientific and Industrial Research (The Investigation of Atmospheric Pollution, Twenty-fifth Report on Observations in the year ended 31st March 1939. Published by H.M. Stationery Office. Price 2*sh.* 6*d.* net). The seasonal variation of pollution in cutting off daylight from the centres of towns is brought out in diagrams. The report also contains an article on the effect which atmospheric impurities have upon building stones.

A brief account of the valuable work carried out at the **Malaria Institute of India** during the year 1939, is given in the Annual Report of the Institute, issued recently. The Institute is financed by the Indian Research Fund Association.

The Field Station of the Institute which was located in Karnal (Punjab), was transferred to Delhi during the year. This step was taken after mature consideration. Delhi with its riverain problem, irrigation problem, rural and urban malaria problems offers an extensive field both for research and teaching.

During the year, the officers of the Institute published 11 research papers. Four numbers of the *Journal of the Malaria Institute*, containing 35 papers, were issued during the year. Other publications of the Institute include, Health Bulletins, Miscellaneous reports and Notes.

The Institute maintains a museum, well equipped in all respects for demonstration purposes in all branches of malariology, both to the members of the medical profession and to laymen.

The intensive antimalarial operations in progress in the Delhi urban area were continued. The work consists in the application of larvicides, clean weeding of pools, and minor levelling and draining operations. Special attention has been given to the development of oil booms to deal with mosquito breeding in irrigation channels and stormwater drains, and for the prevention of larval drift. The spleen census of school children and fever figures from Delhi dispensaries, showed a fall over the previous year's figures. The cost of the annual, recurring antimalaria measures for the Delhi

urban area is Rs. 64,000 or just over two annas per head per annum of the population protected.

Rural Antimalaria Schemes have been started in various provinces as a result of the grant made by the Government of India to the *Indian Research Fund Association* for the purpose. Such schemes in operation are: 1 in Delhi Province, 3 in United Provinces, 3 in Madras and 1 in Bengal.

Much valuable research has been carried out both in the field and in the laboratory. One of the interesting results recorded relates to the existence of 2 entirely different biological races or species of *A. fluviatilis* as evidenced by the examination of the blood meals of the mosquitoes: the percentage containing human blood in the U.P. Terai is 1·4, as compared with 96·9 in Wynaad series. This finding is in agreement with the results of dissections.

Bose Research Institute.—"Scientific Research and the Future of Indian Industry" formed the subject of the Memorial Address, delivered by Dr. S. S. Bhatnagar at the Twenty-third Anniversary meeting of the *Bose Research Institute* held on the 30th November. The illustrious founder of the Institute was intimately associated with a number of experimental investigations having important industrial applications. To mention only a few, his investigations on the transmission of electric signals through space, and on the rectifying action and photoconductivity of semi-conductors have received due recognition in the field of industry. A reference to this aspect of Sir J. C. Bose's work is to be found in the Director's annual report presented at the meeting.

The report also gives a resume of the work carried out by the research staff in the various departments of the Institute. Results of far-reaching importance have been obtained, and the Director must be congratulated for the successful manner in which he has conducted the work of the Institution.

Calcutta University.—The Syndicate has recommended to the Senate, that the Degree of Doctor of Science be conferred *Honoris Causa*, on Sir Nilratan Sircar, Kt., M.A., M.D., LL.D.

The Sir Asutosh Mookerjee Medal in Science, for the year 1939, will be awarded to Dr. B. Mukhopadhyay, M.B., M.D., D.Sc., in consideration of his thesis entitled, "Search for some Ephedrine-like Antispasmodic Remedies" and to Dr. Dinescandra Sen, D.Sc., for his thesis entitled, "Studies in the Camphor Series", the value of the medal being equally divided between the two candidates.

Andhra University: Natural Sciences College.—The Senate, at its meeting held on the 5th December, sanctioned the proposal of the Syndicate that a "Science College in the Faculty of Science be instituted; that Honours B.Sc. Degrees be instituted in Botany, Zoology and Geology; that Honours and Pass B.Sc. courses be instituted in Botany, Zoology and Geology in the above college and that the required cadres of the teaching staff in each of the three branches of learning be instituted". The Senate placed on record, its sense of deep gratitude to the Government of Madras for their generous grant to the Natural Sciences College.

This decision of the University is an important landmark in its history. The Government have sanctioned a capital grant of 3½ lakhs of rupees and a recurring grant of Rs. 40,000 for establishing the college.

SEISMOLOGICAL NOTES

During the month of November 1940 one great, one moderate and six slight earthquake shocks were recorded by the Colaba seismographs as against one great and six slight ones recorded during the same month in 1939. Details for November 1940 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
1940		H.	M.	(Miles)		(Miles)	
November 4	Slight	14	00	1200	Hindukush Mountains	125 (approx.)	Felt in Peshawar
6	Slight	21	41	2090			
7	Slight	19	28	4140		260 (approx.)	
10	Great	7	9	3140	44°·5 N., 27°·0 E., in Rumania (Tentative)		Destructive in Rumania
13	Slight	17	6	1730			
19	Moderate	20	32	4280	In or near Japan		
20	Slight	23	30	1270	Near 36° N., 71° E., in the Hindukush mountains	115 (approx.)	Felt severely in Peshawar
27	Slight	20	12	5430			

MAGNETIC NOTES

The month of November 1940 was magnetically much more disturbed than the preceding month. There were 7 *quiet* days, 15 days of *slight* disturbance and 8 of *moderate* disturbance as against 10 quiet days, 19 days of slight disturbance and 1 of moderate disturbance during the corresponding month of 1939.

The day of greatest disturbance during November 1940 was the 25th and that of least disturbance the 10th. The classification of individual days is shown below.

Quiet days	Disturbed days	
	Slight	Moderate
2, 3, 8, 10, 11, 18, 28.	1, 3, 5, 7, 13-17 19, 20, 24, 26, 27, 30.	4, 9, 12, 21-23, 25, 29

There were three magnetic storms of moderate intensity during the month as compared with one of the same intensity during November 1939. The monthly mean character for November 1940 is 1·03 as against 0·70 for November of last year. M. R. RANGASWAMI.

ASTRONOMICAL NOTES

The Earth will be at perihelion on January 3, 1941.

Planets during January 1941.—Mercury after superior conjunction with the Sun on January 11, passes into the evening sky, and about the end of the month can be seen low down near the western horizon immediately after sunset. Venus continues to be a morning star and is gradually getting closer to the Sun; it will be visible for about an hour and a half before sunrise. Near the planet, and to the west of it, is Mars which is still faint and not favourably situated for observation.

Jupiter and Saturn continue to be apparently close to each other; the former which is in quadrature with the Sun on January 27, is a conspicuously bright object near the meridian at sunset. On January 10 Saturn will be at one of the stationary points of its geocentric orbit, and will afterwards resume its eastward motion among the stars. It will be in quadrature with the Sun on January 28. The Moon will closely approach the planet to a distance of about half a degree on the evening of January 7.

Algol.—Minima of Algol that can be conveniently observed in India, will occur on January 6, $0^h.5$, January 8, $21^h.4$, January 28, $23^h.1$ and January 31, $19^h.9$. The change in brightness is easily noticeable about an hour and a half before and after the times given. T. P. B.

ANNOUNCEMENTS

The Indian Statistical Conference Benares, 1941.—The fourth session of the Indian Statistical Conference will be opened by His Excellency the Governor of the United Provinces at Benares on Thursday, the 2nd January 1941, at 2-30 p.m.

As in previous years the Statistical Conference will proceed with its work in close cooperation with the Indian Science Congress; and four joint meetings have been arranged with four sections of the Congress. The Provisional Programme is given below:—

2nd January.—2-30 p.m. Opening Ceremony.

3rd January.—11 a.m. Joint meeting with the Anthropology Section of the Indian Science Congress: Discussion on "Correlational Analysis of Anthropometric Material". 2-30 p.m. Session for Applied Statistics.

4th January.—11 a.m. Joint meeting with the Mathematics Section of the Indian Science Congress. 2 p.m. Joint meeting with the Medical Section of the Indian Science Congress: Discussion on "Growth Studies with special reference to Nutrition and Public Health".

5th January.—Whole-day Excursion.

6th and 7th January.—Reading of Papers.

8th January.—2 p.m. Joint meeting with the Agriculture Section of the Indian Science Congress: Discussion on "Standard Yields of Crops".

The Government of India, the different Provincial Governments, many of the important Indian States and Universities in India have given official recognition to the Conference and are expected in many cases to send delegates.

Members of the Indian Science Congress are cordially invited to attend the Opening Ceremony and all Sectional meetings and Joint discussions. Cards for the Opening Ceremony will be distributed from the Science Congress Office.

Indian Ecological Society.—The first meeting of the above Society will be held on Tuesday, 7th January 1941, at 1-30 p.m., at Benares to transact the following business. Exact place of the meeting will be notified at Benares.

(1) Election of Office-bearers for 1941. (2) Discussion of the Constitution of the Society. (3) Discussion about the future programme of the Society. (4) Any other business they may be permitted by the Chairman of the meeting.

Proceedings of the Royal Society of Edinburgh.—Owing to the national necessity for exercising the strictest economy in paper, and in order to reduce the expense of printing and publication, the Royal Society of Edinburgh has decided that, as from Vol. LXI, 1940–41, the *Proceedings* shall be published in TWO SECTIONS, *viz.*, "A" (the Mathematical and Physical—including Astronomy, Chemistry, Mathematics, Metallurgy, Meteorology, and Physics) and "B" (the Biological—including Anatomy, Anthropology, Botany, Geology, Pathology, Physiology, and Zoology). Fellows of the Society and Institutions with which the Society exchanges publications will benefit under this arrangement by having, in smaller compass, papers dealing with the subjects in which they specialise.

No change is proposed in the present form or in the arrangement for the distribution of the Society's *Transactions*.

The Obituary Notices of Fellows, Proceedings of Meetings, List of Fellows, Prizes, etc., formerly published as APPENDICES at the end

of each session's volume of *Proceedings* will, under the new scheme, be published separately, and will be sent normally to all Fellows and to those exchanges specially desiring to receive them.

Chronica Botanica.—The International Plant Science News magazine, established in Holland in 1935, is being published fortnightly in the U.S.A. from October 7, 1940 onwards (annual subscription, \$7·50, foreign and domestic, post free). It will continue to publish articles, discussions, digests, communications on the scientific, methodological and practical aspects of all branches of pure and applied plant science, news from institutions and societies, personalia, book reviews, queries, etc.

The "New Series of Plant Science Books" is being continued in the U.S.A., three volumes will be ready soon. Our first American List will be issued early this winter together with the annual questionnaire of Chronica Botanica. We will continue our Addressbooks and World List when international circumstances permit.

All correspondence, botanical specimens, journals, etc. for Dr. and Mrs. Verdoorn should now be sent to Chronica Botanica, P.O. Box 151, Waltham, Massachusetts, U.S.A.

Manufacture of Aluminium in India.—The Government of India, by a resolution, announce that "in view of the fact that the production of aluminium in this country is an urgent war necessity, the Government of India are pleased to give an assurance to all who wish to undertake the manufacture in India that, provided their affairs are conducted on sound business lines they will be given such measure of protection against unfair competition from outside India after the war as may be necessary to enable them to continue their existence."

Our attention has been drawn to an error in respect of the cost of the book "Science in War", review of which has appeared in *Current Science*, Vol. 9, No. 11, p. 508, the price of the book is 6*d*. and not 6*sh*.

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We acknowledge with thanks the receipt of the following:—

"Allahabad Farmer," Vol. 14, No. 5.

"Journal of Agricultural Research," Vol. 60, Nos. 8–12.

"Agricultural Gazette of New South Wales," Vol. 51, Part. 9.

"Indian Journal of Agricultural Science," Vol. 10, Part 5.

"The Nagpur Agricultural College Magazine," Vol. 15, No. 1.

"Journal of the Annamalai University," Vol. 10, No. 1.

"Journal of the Indian Botanical Society," Vol. 19, Nos. 1–3.

"Contributions from The Boyce Thompson Institute," Vol. 11, No. 4.

"The Journal of Chemical Physics," Vol. 8, Nos. 8–9.

"Journal of the Indian Chemical Society," Vol. 17, No. 8.

"Experiment Station Record," Vol. 83, Nos. 1–3.

"Indian Forester," Vol. 66, Nos. 11–12.

"Indian Farming," Vol. 1, Nos. 9–11.

"Bulletin of the Indian Central Jute Committee," Vol. 3, Nos. 7–8.

"Review of Applied Mycology," Vol. 19, Parts 8–9.

"Indian Medical Gazette," Vol. 75, Nos. 10–11.

"The Merck Reports," Vol. 49, No. 4.

"Journal of Nutrition," Vol. 20, Nos. 2 and 4.

"American Museum of Natural History," Vol. 46, No. 2.

"Nature," Vol. 146, Nos. 3694-97 and 3703.

"Journal of Research" (National Bureau of Standards), Vol. 25, Nos. 1 and 3.

"Canadian Journal of Research," Vol. 18, No. 8.

"Sky," Vol. 4, No. 11.

"Lingnan Science Journal," Vol. 19, No. 4.

"Science and Culture," Vol. 6, Nos. 5–6.

"Ceylon Journal of Science," Vol. 3, Part 1 (Anthropology).

"Indian Trade Journal," Vol. 138, Nos. 1790–98.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 10, Part 3.

"Journal of the Royal Society of Arts," Vol. 88, Nos. 4568–69.

"Report of the Executive Committee of the Council of the University of Rangoon."

"Chemical Analysis of Kolhapur Waters," by J. W. Airan and S. V. Shah.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

November 1940. SECTION A.—C. V. RAMAN AND N. S. NAGENDRA NATH: *The two types of x-ray reflection in crystals.* The x-ray reflections of the Laue type are elastic collisions of the photons with the crystal considered as a structure with static space periodicities. The modified or quantum reflections are inelastic collisions in which the photon excites the vibration of the crystal lattice and is itself reflected by the dynamic stratifications of electron density arising from such vibrations. V. T. CHIPLONKAR: *The localisation of the discharge in ordinary and canal-ray tubes.* K. VENKATESWARLU: *Raman spectrum of sulphur.* The complete Raman spectrum of nine lines for a single crystal of rhombic sulphur has been recorded. The effect of crystal orientation on the Raman spectrum has also been studied. S. MINAKSHISUNDARAM: *On the expansion of an arbitrary function in a series of eigenfunctions of boundary value problems.* V. SUBBA RAO AND T. R. SESHADRI: *Chemical investigation of Indian lichens. Part I.—Chemical components of* Roccella montagnei. P. BHASKARA RAMA MURTI AND H. KRISHNASWAMY: *Wax from* Butea frondosa *flowers.* P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *Occurrence of free butein and butin in the flowers of* Butea frondosa. DARBARA SINGH: *Scattering of polarised light in colloids.* B. R. SETH: *Transverse vibrations of triangular membranes.* R. K. ASUNDI: *New bands in the triplet carbon system.* A few new band heads belonging to the triplet carbon band system of CO are reported.

November 1940. SECTION B.—MISS K. P. NALINI: *Structure and function of the nidamental gland of* Chiloscyllium griseum (*Mill. and Henle*). N. L. SHARMA: *Royite, a new variety of quartz from the Jharia Coal-field.* T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Studies in the Capparidaceæ, VIII.—The cytology of* Capparis Zeylanica *Linn., and related genera.*

Indian Association for the Cultivation of Science: (*Proceedings*)

August 1940.—P. L. BHATNAGAR: *On the origin of solar system.* S. R. KHASTGIR AND ANIL KUMAR RAY: *On the intensity variations of the down-coming wireless waves from the ionosphere.* S. P. CHAKRAVARTY: *On wide band-pass effect in crystals associated with negative impedance elements and development of wide-band low-loss crystal band-pass filters.* A. K. DAS AND B. G. NARAYAN: *An apparent influence of the earth on solar prominences.* S. S. BANERJEE AND PARAMANAND: *Variation of field-strength in the vicinity of an ultra-short-wave horizontal transmitting aerial.*

Indian Botanical Society: (*Journal*)

November 1940.—D. CHATTERJEE: *Two new anonaceæ from Assam and Burma.* C. V. KRISHNA IYENGAR: *Development of embryo-sac and endosperm-haustoria in some members of scrophularineæ.* V. Ilysanthes hyssopioides *Benth.*, Bonnaya tenuifolia *Spreng.* SHRI RANJAN: *Studies on the photochemical action in plants. I.—The respiration of entire* Pistia *plants in light.* M. ANANTASWAMY RAU: *Studies in the Apocynaceæ.* T. TATACHAR: *The development of the embryo-sac and formation of haustoria in* Lantana indica *Roxb., and* Stachytarpheta indica *Vahl.* K. V. RAGHAVA RAO: *Gametogenesis and embryogeny in five species of the convolvulaceæ.* M. J. THIRUMALACHAR: *A method for germinating and staining teleutospores.* D. CHATTERJEE AND S. K. MUKERJEE: *Some new plants from India and Burma.* SHRI RANJAN: *Studies on the photochemical action in plants. II.—Photosynthesis in leaves at different temperatures.* SHRI RANJAN AND BRIJ BEHARI LAL SAKSENA: *Studies on the photochemical action in plants. III.—The influence of visible light on the rate of respiration of some coloured flowers.* SHRI RANJAN: *Studies on the photochemical action in plants. IV.—The effect of violet and ultra-violet radiations on plant respiration.* S. DORAISWAMI: *On the morphology and cytology of* Eudorina indica *Iyengar.* K. BISWAS: *Systematic position of a little known flowering plant from South Burma.* P. SEN: *Effect of anthocyanin pigments on the rate of photosynthesis in* Eranthemum *Spp.* M. O. P. IYENGAR AND S. KANTHAMMA: *On* Hormidiella, *a new member of the ulotrichaceæ.* M. O. P. IYENGAR AND S. KANTHAMMA: *A note on* Ulothrichopsis viridis *gen. et sp. nov.* S. KANTHAMMA: *On the life-history of* Characium terrestris *sp. nov.* M. O. P. IYENGAR AND K. R. RAMANATHAN: *On the reproduction of* Anadyomene stellata (*Wulf.*) *Ag.*

Meteorological Office Colloquium, Poona:

November 19, 1940.—B. N. DESAI, A. K. ROY AND N. K. SUR: *Some remarkable variations in the height and temperature of the tropopause found in Indian sounding balloon records.*

November 29, 1940.—C. G. PENDSE: *Seismic investigations of the palæozoic floor of East England.*

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